THE HORSE IN LATE PLEISTOCENE AND HOLOCENE BRITAIN

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February 2000

Abstract

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Until now, the horse was one of the few members of the British Late Pleistocene and Holocene fauna which had yet to be fully investigated. In this thesis, chronological, palaeoecological and morphological data based on direct investigations of British and European fossil and sub-fossil horses are presented. The time-frame encompasses the latest certain wild horses in Britain and continental Europe through to the early diversification of domestic types, and thus spans the interval from c. 15,000-2,000 years before present (BP). The gazetteers presented are the result of a thorough survey and intensive study of all relevant British (as well as selected continental) collections of fossil and sub-fossil horse material. Furthermore, the incorporation into this project of a radiocarbon accelerator dating programme has provided 45 new, direct horse dates from 31 British/Irish sites. A systematic review of all new and previously obtained dates reveals a complex pattern of chronological and geographical distribution for horses during the study interval. These data are interpreted with reference to known climatic and environmental events which are detailed. Further investigations are presented which reveal the ecological reactions of wild horses to underlying environmental factors such as climate change and vegetational succession. Questions of body size variability as well as taxonomic and relationship issues are addressed by means of a detailed morphological investigation. Cranial and postcranial measurements are employed to expose variation and diversification of size and form among wild and domestic animals of three key periods: Mid-Devensian, Late Glacial/early Post Glacial, middle to later Post Glacial. In addition, body size comparisons are made between British and continental horses for each episode. Finally, there is discussion of alternative ways of revealing relationships between ancient and modern horses. In particular, molecular evidence is reviewed with the aim of assessing its value to taxonomic, morphological and chronological studies

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Acknowledgments

The author wishes to thank all those who assisted in my quest to discover as much as possible about wild and early domestic horses of the British Late Pleistocene and Holocene. In particular, I am indebted to Adrian Lister for all his guidance, support and expert advice. I will never forget the numerous meetings and the e-mail correspondence we maintained while I was writing-up. Also, I must show gratitude to Andy Currant and Roger Jacobi who were instrumental in keeping me on the right track as well as offering invaluable advice and discussion regarding numerous aspects of Late Glacial chronology, faunas and environments.

I am grateful to Helen Stanley and Miranda Kadwell who provided laboratory training and advice. Above all, they made me feel welcome within the Conservation Genetics Group at the Institute of Zoology. I would also like to thank Sue Baker and Alma Swan for their contribution of valuable information on modern breeds as well as key specimens which included countless horse hair samples. Warmest appreciation goes out to Kim Dennis-Bryan who contributed all the above and more including many memorable conversations and insights regarding horses of all colours, shapes and sizes.

Thanks to the curators and assistants in all the museums which I contacted and visited throughout the United Kingdom and in Belgium, France and Germany. Special thanks goes to Andy Currant and Richard Sabin of The Natural History Museum, London as well as Chris Hawkes of Wells Museum and the University of Bristol Spelaeological Society (UBSS) Museum.

The Natural Environment Research Council (NERC), NERC Oxford Radiocarbon Accelerator Service (ORAS) and the University of London Central Research Fund (CRF) contributed to the support of this project. Specifically, the new radiocarbon dates presented in this thesis were obtained through an award from NERC ORAS together with a grant from the University of London CRF

To all those who aided me in many other ways too varied to mention, I offer my sincere appreciation They include Elaine Turner, Juliet Clutton-Brock, Ruth Charles, Ann Forsten, H.-P Uerpmann, Martin Street, Marsha Levine and Paul Pettitt Special thanks to Marion Duffin for sparing the time and energy in creating a wonderful line drawing of the Bruniquel horse engraving I must also express thanks to my fellow Ph D students Danielle Schreve, John Stewart and Fred Owen for sharing in the

postgraduate experience. To Danielle, a special thank you for our museum visits and Palaeo chats, both professional and personal.

To my parents, thank you for all your help from across the miles Your support was much appreciated and greatly needed. Last, but certainly by no means least, a huge thank you goes to Paul, my husband. Much appreciation for your dialogue, support and patience. Your computing advice has been invaluable. Above all, thanks for keeping the faith.

Chapter One Introduction

1.1 Background and research aims

1.1.1 Introduction

The study of the horse through prehistory is a subject of enduring fascination. Whether the topic be horse morphology, physiology, ecology, behaviour or relations with humans, it is sure to stir up much interest and controversy. Understanding the fate of wild horses and the origins of domestic horses has consequences for our concept of all modern breeds and species, free-living or captive. This topic forms the essence of the present work, with special reference to Britain, Ireland and continental (mainly north-west) Europe.

The principal time-frame of the thesis has been chosen to encompass the latest certain wild horses in Europe, through to the early diversification of domesticates, and thus spans the interval from around 15,000 to 2,000 years before present (BP) (i.e. the Late Glacial and Post Glacial [or Holocene]). Therefore, this study bridges the gap between the deeper palaeontological past and the present day. Britain is a country rich in Pleistocene fossiliferous material, with fossil horses available from both cave and open sites. During the time interval in question, these include both archaeological and natural accumulations. In this study, a survey and intensive study of all relevant British collections, with selected continental collections, will be undertaken. The materials utilised and the methods employed in this thesis will be described within each of the two relevant data analysis chapters (chapters 4 and 5), rather than in an independent chapter.

1.1.2 Research aims

A number of interlocking questions regarding British Late Pleistocene and Holocene horses (particularly those of the Late Glacial to middle Post Glacial) will be tackled in this thesis. The key topics can be briefly summarised as follows:

a) Taxonomy, including past concepts on the origin of modern horses

In published accounts, domestic horse origins have been heavily debated (e.g. Ewart, 1905-6, Nobis, 1974; Uerpmann, 1990; Groves, 1991), and the taxonomy of the horse throughout the Late Pleistocene to Holocene of Britain and north-west Europe has been confused. It will be necessary to investigate the evolution of British and European horses during this period using relevant nomenclature, and from it construct an easy-to-read diagram in order to clear up the confusions that exist about the possible origins of domestic horses. Also, a literature review will be carried out on the subject of the horse in prehistory, to investigate various 'types' of wild horse which have been suggested including the various ecotypes (e g. steppe horse, tundra horse, forest horse, etc.) and to determine why these were suggested in the first place (e.g. European cave art).

b) The history of horses in the Late Pleistocene to Holocene of Britain and Europe with special reference to chronology, geography and environment

Where, when and in what types of environments did horses live during this period? The geographical and temporal distribution of sites with horse finds will be plotted, as well as the 'negative evidence' of sites lacking horse. Particular attention will be paid to provenance, stratigraphy and dating. Since a majority of Late Pleistocene and some Holocene sites with horse happen to be cave sites, emphasis will be placed on British bone caves and their stratigraphy and taphonomy. Sites with good sample sizes are especially valuable, but even deposits with only a little horse material can be important in providing a record for a particular time and place. The survey of British sites will be exhaustive, and some crucial Irish and continental samples will also be directly studied, making this the most wide-ranging study of its kind. The dating of horse remains is an essential part of the project. Associated dates are already available for numerous sites with horse, but until now, there has been a lack of directly-dated horse specimens. In this project, a survey of pre-existing radiocarbon dates, and numerous new ^{14}C datings will be undertaken on material from sites whose stratigraphy is well-known. The incorporation into this project of a direct radiocarbon accelerator dating programme will clear up some uncertainties relating to the presence of horses during the study interval (i.e their continuity throughout Britain). For instance, it is necessary to determine whether wild horses really became extinct sometime during the Boreal

period in Britain (c. 9,500-7,500 BP) or whether they survived in small numbers through the early Post Glacial.

As with much Quaternary research, this investigation takes account of palaeoenvironmental factors such as changes in climate, flora and fauna, and biogeography. The results of ancillary studies based on pollen, beetles and oxygen isotopes will be collated, providing important information on regional environments against which to interpret the patterns of horse occurrence through this period of severe environmental fluctuation. Additionally, the connections Britain had with the Continent and Ireland at times of lowered sea level are relevant to theories of possible immigrations of horses and/or replacements of one horse 'type' by another. Environmental factors such as inter- and intra-specific competition will also be taken into account. Furthermore, it will be necessary to investigate the effects of this competition as well as climate, and food/water availability on individuals and populations.

c) Morphological variation

The morphological study of fossil and sub-fossil bones and teeth provides information about the size, shape and 'types' of animals which roamed Late Pleistocene and Holocene habitats. The morphology of horses will be examined using standardised measurements of elements to reveal differences or similarities between individuals and/or populations. Bones and teeth provide ecologically important variables such as size, stoutness, shape, abnormalities (palaeopathology) and tooth wear. Also, using specific measurements, body size (e g. withers height and body weight) can be estimated. Furthermore, appropriate graphical and statistical techniques will be employed to analyse the intra-specific data.

The current study is innovative because it incorporates an investigation of horse morphology using directly dated specimens. In this way, size variation and change can be documented through time, spanning wild and domestic horses, ancient and modern, thus providing information on the relationships between these groups Once variation is established, factors influencing morphology can also be investigated by incorporating data on climate, vegetation, geography and associated fauna. Furthermore, morphological comparisons between extant and ancient animals will be

made to help unravel the currently muddled taxonomy alluded to above. Additionally, an examination of the variables associated with growth, nutrition, ageing and sexing of horses will supplement the morphological study.

d) Supplementary evidence in the study of Late Pleistocene and Holocene horses

As a complement to the taxonomic, chronological, distributional and morphological studies, additional data will be employed in the investigation of Late Pleistocene and Holocene horses of the British Isles as well as continental Europe. Two topics in particular are detailed below.

(i) Molecular evidence

Molecular data will be employed to investigate the origins of domestic horses. Using morphological and molecular evidence in conjunction is a new approach which may help to separate wild from domestic horses as well as investigate their relationships. The major aim is to explore relatedness among British fossil and sub-fossil horses, the tarpan (*Equus ferus ferus* Boddaert,1785), Przewalski's horse (*Equus ferus przewalskii* Poliakov,1881) and domestic horses (*Equus caballus* Linnaeus,1758). The molecular evidence will consist of mitochondrial DNA (mtDNA) data and analyses. Using PCR (Polymerase Chain Reaction) and sequencing data, it will be possible to compare mtDNA from domestic breeds including so-called 'primitive' breeds (e.g. Exmoor pony) and the wild Przewalski's horse. It may also be possible to utilise newly obtained molecular data, i.e. ancient mtDNA obtained from fossil remains in Britain and Eurasia (e.g. horse bones and teeth) and the extinct eastern European 'wild' horse, the tarpan. The relevant molecular evidence (e.g. sequence data) can then be compared in order to assess relatedness between domestic breeds and wild species. Further, it may be possible to investigate the origins of populations using molecular as well as morphological methods.

(ii) Human-Horse interactions

The human-horse relationship is an important aspect of the project and will be stressed throughout Horse remains provide important data relating to interactions between humans and horses during the Late Pleistocene to Holocene, and this study of relations in Britain is novel Additionally, specific evidence of human activity through artefacts found at particular sites are to be investigated (e.g. flint, worked bone, charcoal). Also,

fossil remains will be examined for traces of human-horse interactions (e g. cutmarks and bone breakage as evidence of butchery and hunting). Finally, an attempt will then be made to determine domesticity using both size change and artefactual evidence (e.g. antler cheek pieces).

Before the investigation starts in earnest, it is necessary first to introduce the animal at the very heart of the study: the horse. Thus, the following sections of this introductory chapter provide a modern backdrop against which interpretations regarding the ecology, physiology and behaviour of ancient horses will be assessed.

1.2 Introduction to the Equidae and the horse

The 'true' horse, as a member of the genus *Equus*, is the product of millions of years of evolution. Fellow members of this genus comprise the zebras and the asses. The horse and ass groups each include wild and domestic representatives, while the zebra group has only wild members. They reveal their close relationships in their ability to interbreed in captivity (Klingel, 1974). According to Groves and Willoughby (1981), the species within *Equus* are "well-separated" into six subgenera (table 1.1) based on morphological, genetic and behavioural differences. Although these groups have many traits in common which set them apart from other ungulates, each has its own unique set of adaptations, and each is successful in environments which pose both physiological and behavioural challenges. For example, free-living Exmoor ponies can survive year-round on Exmoor, Devon in inhospitable climatic conditions without aid from humans (Baker, 1993; Gates, 1979, 1981). Their thick, two-layered, water-repellent winter coats and body shape protect them from the elements, and like other free-living equids, they can adjust their behaviour to suit seasonally variable environments.

1.2 1 Evolution and taxonomy

The success of *Equus* goes back millions of years Many extinct species and types are now known only from abundant fossil remains found in both Eurasia and North America MacFadden (1992) can pinpoint 25-30 valid extinct and living species worldwide, their distribution being most widespread during the Pleistocene epoch. The three groups seen today had their ancestors in two main fossil types which evolved in

Table 1 1 Modern Equid Taxonomy (Order· Perissodactyla; Family: Equidae Gray,1821)

GENUS	SUBGENUS	SPECIES	SUBSPECIES
Equus	*Hippotigris* H Smith,1842 (Mountain zebras)	*zebra*	*E. z. zebra* Linnaeus,1758 Cape Mountain zebra
			E. z. hartmannae Matschie,1898 Hartmann's Mountain zebra
	Dolichohippus Heller,1913 (Grevy's zebras)	*grevyi*	*E. grevyi* Oustalet,1882 Grevy's zebra
	Quagga Shortridge,1934 (Plains zebras)	*burchelli*	*E. b. burchelli* Gray,1824 Burchell's zebra (Extinct 1930)
			E. b. antiquorum Hamilton Smith, 1841 Damara zebra
			E. b. boehmi Matschie,1892 Grant's zebra
			E. b. crawshayi , Crawshay's zebra
			E. b. zambeziensis , Upper Zambezi zebra
			E. b. chapmani, Chapman's zebra
		quagga	*E. quagga* Gmelin,1788 Quagga (Extinct)
	Asinus Gray,1822 (African wild asses)	*africanus*	*E. a. africanus* Fitzinger,1857 Nubian wild ass (Extinct)
			E. africanus Heuglin & Fitzinger,1866, North African wild ass
			E. a. 'atlanticus' P.Thomas,1884 Algerian wild ass (Extinct c.300 AD)
			E. a. somaliensis Noack,1884 Somali wild ass
	(DOMESTIC ASSES)	*asinus*	*E. asinus* Linnaeus,1758 Domestic donkey
	Hemionus Stehlin & Graziosi, 1935 (Asian wild asses)	*hemionus*	*E. h. hemionus* Pallas,1775 North Mongolian dzigettai
			E. h. onager Boddaert,1785 Onager
			E. h. khur Lesson,1827 Indian wild ass
			E. h. hemippus I.Geoffroy,1855 Syrian wild ass (Extinct 1927)
			E. h. luteus Matschie,1911 Gobi dzigettai
			E. h. kulan (Groves & Mazak,1967) Kulan
		kiang	*E. k. kiang* Moorcroft,1841 Western kiang or Kiang of Tibet
			E. k. polyodon (Hodgson,1847) Southern kiang
			E. k. hodereri Matschie,1911 Eastern kiang
	Equus Linnaeus,1758 . **'True Horses'**		
	(WILD HORSES)	*ferus*	*E. f. ferus* Boddaert,1785 Steppe or Plains Tarpan (Extinct c 1900)
			E. f. sylvestris von Brinken,1828 Forest Tarpan (Extinct)
			E. f. przewalskii Poliakov,1881 Przewalski's wild horse (Extinct? in wild c.1960)
	(DOMESTIC HORSES)	*caballus*	*E. caballus* Linnaeus,1758 Domestic horse

Sources Clutton-Brock (1992a); Corbet (1978); Duncan (1992); Gentry *et al.* (1986); Grizimek (1975); Groves (1994); Groves and Willoughby (1981); Wilson and Reeder (1993).

the New World: the stenonines (or zebrines, including the asses) and the caballines (or true horses). It is believed that early *Equus* in the Old World (first occurrence 2.5-3.0 Ma ago) belonged to the stenonine group, while the caballines, being more derived morphologically and behaviourally, appeared later (0.75 Ma ago) and eventually replaced the stenonines (Forsten, 1992) in Eurasia. In general, the two types can be distinguished by their lower cheek tooth morphology; stenonines having a V-shaped entoflexid (i.e. linguaflexid or double-knot) with a deep ectoflexid, and the caballines having a U-shaped entoflexid with a shallow ectoflexid (MacFadden, 1992) (see fig. 1.1). Additionally, Forsten (1992) notes that morphological comparisons together with molecular studies (e.g. George and Ryder's (1986) use of mitochondrial DNA (mtDNA) to reveal phylogenetic relationships) support these distinctions in extant stenonine and caballine species (i.e. zebras/asses and domestics/Przewalski's horses respectively). The 'true' caballine horses of the Pleistocene/Holocene in north-west Europe are the group at the centre of the current study.

1.2.2 Present global distribution

Today, no truly wild horses survive as free-living animals unmanaged by humans. The only wild horse still in existence, the Przewalski's horse (or Takhi), can be found only in zoos, wild animals parks, and managed reserves. This horse is noted as the 'wild type' by many authors trying to describe the behaviour and appearance of prehistoric wild horses. Before the restriction of their ranges, which led to their

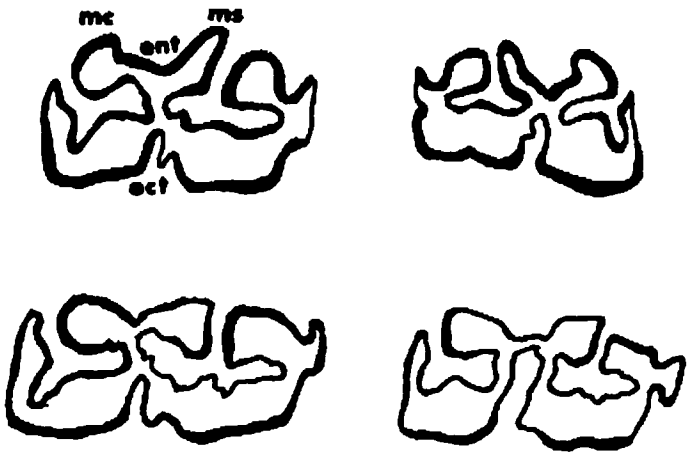

Fig. 1.1. Occlusal surface of lower cheek teeth (premolar at left, molar at right) for caballine (top) and stenonine (bottom) horses. mc= metaconid; ms= metastylid; ent= entoflexid; ect= ectoflexid (from Forsten, 1992).

eventual demise, Przewalski's horses once populated large areas of central and western Asia (Bokònyi, 1984) In contrast, the modern domestic relatives of these wild horses have had more success in spreading themselves geographically, being found in almost every country, on every continent. Of course, humans have been largely responsible for the spread of the domestic horse throughout the world, but in many circumstances, domestic horses have reverted to a wild state and now range free (i.e. feral or semi-feral) without much support from man. From California to Japan, and from Alaska to Australia, feral horses can be encountered (e.g. the mustangs of western USA and the brumbies of Australia). Feral herds have even established themselves on islands as remote as the Galapagos (Lever, 1985). More interestingly, Bökönyi (1984) cites Mennick's observations that "with each generation, feral horses more closely resemble the Mongolian wild horse simply because their characteristics give a better chance for survival under difficult conditions".

1 2.3 Breeds and types of wild and domestic horses

Terminology

Domestic horses are grouped in several different ways using terms such as 'breed', 'type', 'pony', 'light' or 'heavy'. According to Edwards (1993), a breed can be defined on two levels as being: 1) a group of equines which inhabit an area where the environment and group members exert an influence producing animals of similar conformation (i.e. shape), coat colour, height, action, and general character; or 2) a group which relies upon the existence of a stud book and pedigree registration where the animals are bred selectively through time to "ensure consistent production of stock sharing common and clearly defined characters" (i.e. size, conformation, action, perhaps colour). The first definition refers to animals which are not fully under human management, whereas the second refers to equines dependent on humans for survival. In the current study, the term 'type' will be applied to equines which fall under the former category and the term 'breed' will be applied to those which represent the latter (i e true domestic horses)

The main differences between ponies, light and heavy horses are their weights, body proportions, surface areas, gaits and heights (Edwards, 1993). All three can be separated into breeds and types. A pony is generally an equine whose withers height (WH) is below 15hh (hh = hands high, 1 hand = 10cm) or between 10-15hh. Edwards

(1993) also believes that ponies differ from horses on the basis of their proportions (e g. WH being less than the trunk length in Shetland ponies), their unique character (e g. hardiness, even temperament), and their size. So-called 'Light' horses (e g. Arabs) are generally between 15-17.2hh in height and make outstanding riding horses, while 'Heavy' horses (e g Clydesdales) range between 16-18hh and have immense strength (Edwards, 1993).

Phenotypic traits

Certain features characterise caballine horses phenotypically, thus distinguishing them from their equine cousins, the zebras and asses. The mane is much longer and thicker in the horse. Also, caballine horses have longer, 'fuller' tails than other equids (Groves and Willoughby, 1981). On the limbs, horses possess oval-shaped, cornified spots (the chestnuts) on the inner sides of both fore- and hindlimbs near the knee/hock, whereas asses and zebras only possess a single pair (on the forelimbs). The function of these structures is unknown, although Willoughby (1974) notes Lydekker's suggestion in 1912 that the chestnuts are glandular structures which once functioned as scent glands, helping to maintain herd cohesion. Another suggested function for the chestnuts is as rudimentary pads for the side toes (Bökönyi, 1984). Furthermore, the hoofs of horses are large, high, rounded and slightly concave on the sole, while those of asses and zebras are narrower and commonly smaller (Groves and Willoughby, 1981).

Since the Przewalski's horse (fig. 1.2) is thought to be the sole extant wild representative of the caballines, its coat colour and pattern is also described as the 'wild type', a trait similarly exhibited by other living wild equids (e g. the asses: fig. 1.3). This so-called wild colour and pattern consists of a coat with a dark upper part and lighter colouring on the flanks, belly and inner legs. Darker pigmentation is seen at the extremities (i e. ear tips, lower parts of legs, outer long hairs of mane and tail), the dorsal (or eel) stripe down the back, and the leg and shoulder stripes (Geurts, 1977). See chapter 2 for a more detailed discussion of the anatomy of Przewalski's horse.

The body striping that is seen in many wild and domestic horses is a trait which suggests that all modern equines (caballines and zebrines) derive from striped ancestors. Many theories have been put forward as to the function of stripes on equids, ranging from their being a form of camouflage, to pest avoidance and body temperature regulation (Nowak, 1991). The most convincing argument for striping is

Fig. 1.2. The Przewalski's wild horse (*Equus ferus przewalskii*)

Fig. 1.3. The onager (*Equus hemionus onager*), an Asian wild ass. (after http. www.corbis com Steve Kaufman).

that of Kingdon (1979, 1984), suggesting that stripes, as a visual stimulus, create and maintain healthy group cohesion and socialization which facilitate intense congregations of animals in tropical savannah habitats where resources are often unevenly distributed and sometimes occur in concentrated patches. On the other hand, it appears that equids living in colder, more temperate regions have lost the intense striping pattern seen in extant zebras. Kingdon (1979, 1984) suggests that in habitats which had well-distributed resources, stripes were not socially beneficial for animals which normally did not need to form large congregations. Furthermore, for the more northerly-based equids, a "crisp" pattern of stripes in their shaggy winter coat could not be maintained. This may indicate that caballine horses evolved from ancestors which were much less intensively striped to begin with.

Genetics

Ever since Benirschke *et al.*'s (1965) pioneering study of chromosome numbers in horses, scientists have attempted a wide variety of equid molecular, biochemical and cytological studies including Ryder *et al.*'s (1978) study of equid chromosome banding, Clegg's (1974) study of horse hæmoglobin polymorphism, Kaminski's (1979) study of the biochemical evolution of the horse and George and Ryder's (1986) study of equid mtDNA. Benirschke *et al.* (1965) determined that the Przewalski's horse has a chromosome complement of 2n=66 whereas the domestic horse is 2n=64. This revelation is the basis for studies which aim to investigate the relationships between the wild and domestic groups. This chromosomal difference is thought to be caused by Robertsonian centric fusion where evolution produces a reduction in chromosome numbers in the more evolved species (i.e. diploid 66 to 64). However, Ishida *et al.* (1995) dispute this theory and believe that recent mtDNA genealogy data may instead support a change in the opposite direction (i.e from 64 to 66)

1.2 4 Morphology and physiology

Groves and Willoughby (1981) attest that proportions of the limbs and characteristics of the teeth and cranium should be used in conjunction when attempting to identify fossil forms. Indeed, today, hippologists use discrete measurements of height and weight to characterise breeds and types of horses. Willoughby (1975) uses over 20 "standard body measurements" (e g. withers height, neck and head length, body weight) to compare various breeds of domestic horses from birth to adulthood,

each measurement reflecting the size and shape of individual cranial and post-cranial elements. Not only can these measurements provide data on the breeds themselves, but they can provide information on sex and age differences within breeds. Adult males and females differ little in overall size; however, in general, stallions are larger, "slightly taller", "heavier-boned" and "thicker-bodied" than mares of the same age (Willoughby, 1974). Moderate sexual dimorphism is noted by Willoughby (1975) to be evident in the "girth" of the third metacarpal (MCIII) where females measure less than 95 percent of the male in domestic horses. With respect to body weight, there is about a ten percent difference between the sexes (Duncan, 1992). Many authors agree that a horse can be considered as 'adult' and fully mature when it reaches the age of five to six years even though each sex is capable of breeding before this age (Duncan, 1992; Willoughby, 1975; Edwards, 1993).

The equine physique, more than that of any other animal, has served it well both in the wild and under domestication. As pointed out by Azzaroli (1992), modern *Equus* has evolved an "extremely simplified monodactyl limb, marvellously adapted to fast running sustained over long distances". Furthermore, MacFadden (1992) stresses the importance of the evolution of the "passive-stay apparatus" which incorporates a distinctive humerus with its intermediate tubercle, not found in other ungulates. In modern equids, this morphology allows them to stand (i.e. resting, feeding) for long periods by "locking" their limbs, thus conserving energy. The same body structure which enables horses to support a sometimes very high body weight (i.e. 500kg plus) provides them with the strength to pull heavy loads (MacFadden, 1992). Humans have exploited these adaptations, most commonly in the use of heavy horses for agriculture and Thoroughbreds for racing.

Inside the horse's mouth lies the key to success in a grassland environment. A full complement of high-crowned (i e. hypsodont) cheek teeth as well as sharp incisors enables the horse to exploit the highly fibrous forage on which it sustains itself. This, together with 'prehensile' lips and an efficient digestive system composed of a fermentation chamber in the highly developed caecum (i e. hindgut), allows the horse and other equids to utilise "food resources inaccessible to similar-sized ruminants" (Janis, 1976). In addition, Berger (1986) notes that equids, as caecal digesters, are at a distinct advantage compared to similar-sized ruminants living on the same low quality diet

1.2.5 Observational studies

Studies of extant free-living horses (and other equids) are essential in understanding their ancestors and close relatives, the wild and early domestic horses of Eurasia. Since fossil remains contribute little direct behavioural information, modern field studies can provide important direct evidence concerning the behaviour, social organization and adaptations of horses and other equids living in a variety of environments under sometimes very extreme conditions (e.g. semi-desert in America) (see table 1.2). It is regrettable that the one truly wild horse no longer lives wild, thus making field studies of this type difficult and rare. Nowak (1991) notes that Przewalski's horses were previously never formally studied in the wild. However, of the few historical observations that have been made, those of the Grum-Grzimajlo brothers in the 1890s, remain one of the most reliable sources of information (Boyd and Houpt, 1994). More recently, studies of Przewalski's horses have had to be made in captivity (i.e. zoos) (Groves and Willoughby, 1981), and today, field studies take place on managed reserves (van Dierendonck and Wallis de Vries, 1996; Roddis and Wakefield, 1997).

Wild equid studies (e.g. Klingel, 1974; Boyd and Houpt, 1994) have been supplemented by world-wide research on free-living domestic herds. Assuming that the behaviour and, with more caution, the ecology of extinct Pleistocene north-west European wild horses was similar to that of modern caballines, the accurate information supplied by several particularly important studies can be utilized in the current project. For example, the feral horses of North America, both western populations of mustangs and eastern populations of island dwelling ponies, provide the most abundant field data (e.g. Berger, 1977, 1983a, 1983b, 1986, 1987; Feist and McCullough, 1976; Welsh, 1973). In Europe, there are many populations of free-living horses and ponies which have been studied over the years. Of the nine breeds of native ponies in the British Isles, the New Forest and the Exmoor stand out, both having been extensively studied in the field (Tyler, 1972; Gates, 1979, 1981; Baker, 1993; Speed and Speed, 1977). Another important European study is that of the Camargue horses stationed on Tour du Valat in south-eastern France. A herd has been maintained and monitored here since 1973 where behaviour and social structure are key research issues (Monard and Duncan, 1996; Feh, 1990).

Table 1 2 Examples of Observational Studies of the Equidae

Study Location	Species	Reference
	Equus caballus	
New Forest (England)	New Forest ponies	Tyler (1972)
Exmoor (England)	Exmoor ponies	Speed and Speed (1977); Gates (1979, 1981); Baker (1993)
Assateague Is. (Maryland, USA)	Assateague ponies	Keiper and Keenan (1980)
Granite Range (Nevada, USA)	Mustangs	Berger (1983a, 1983b, 1986, 1987)
Pryor Mtns (Montana, USA)	Mustangs	Feist and McCullough (1976)
Grand Canyon (Arizona, USA)	Mustangs	Berger (1977)
Sable Is (Canada)	Sable Island ponies	Welsh (1973)
Camargue (France)	Camargue horses	Feh (1990); Monard and Duncan (1996)
	Equus ferus przewalskii	
Eelmoor Marsh (England)	Przewalski's horse	Roddis and Wakefield (1997)
Various	Przewalski's horse	Mohr (1971); Boyd and Houpt (1994)
Prague Zoo	Przewalski's horse	Dobroruka (1961)
Dutch semi-reserves	Przewalski's horse	Feh (1988)
	Equus zebra	
South Africa	Mountain zebras	Klingel (1968, 1969a); Penzhorn (1975); Duncan (1992)
	Equus burchelli	
South Africa	Plain's zebras	Klingel (1967, 1969b); Smuts (1976); Duncan (1992)
	Equus grevyi	
Africa	Grevy's zebras	Klingel (1972); Duncan (1992)

1.2.6 Environments and resources

Habitat preferences

In reference to the abundant Pleistocene/Holocene equid remains found throughout Europe and America, Azzaroli (1992) maintains that equines must have inhabited a wide range of environments. This is reflected in the most recent distribution of wild *Equus*: the asses in the deserts and steppes of Eurasia and Africa, the zebras in the tropical bush, rich parklands, and savannahs of Africa, and the horses in the cooler grasslands of the Northern Hemisphere (Azzaroli, 1992; Kingdon, 1979). The common denominator for this group seems to be the preference for grassland or steppeland, although Woodward (1991) points out that studies of free-living herds suggest that equids are "not ecologically or geographically restricted" to these habitats. For example, horses flourish in the semi-deserts of western USA and Australia; the marshy Camargue region in France; the high elevations of the Rocky Mountains; the windswept islands such as Sable Island, Nova Scotia and Chincoteague/Assateague Islands, off Virginia, USA; the high moorland of south-western Britain; the forests of western Canada; and the tundra of eastern Russia (Duncan, 1992; Rees, 1992; Lever, 1985; Gates, 1981). Duncan (1992) suggests that some of these may be "marginal" habitats, not necessarily the preferred ones, but ones in which free-living animals are merely tolerated by humans. For instance, the wild Przewalski's horse's former range in the arid Dzungarian Gobi was considered to be a sub-optimal habitat; its optimal habitat being the Eurasian steppe ecosystem (e.g. the Pleistocene Mammoth Steppe of Eurasia, the Holocene steppes of central Asia) (van Dierendonck and Wallis de Vries, 1996). Nevertheless, as a testament to their behavioural adaptability and resilience, the horse is able to thrive in areas where other ungulates fail to flourish.

It must be noted, however, that horse survival in the wild is even more dependant on their distinctive digestive anatomy and physiology Like the Przewalski's horse in Mongolia, many of today's free-living horses survive in areas with low quality sparse vegetation which is high in fibre and low in protein, a diet which suits a hindgut fermenter with a highly developed caecum, capable of increasing its daily intake when necessary as well as sustaining faster rates of food passage (Janis, 1976, Janis *et al.*, 1994). With this efficient digestive system, horses are adept at exploiting habitats containing coarse, fibrous vegetation, a resource which other ungulates (e.g. ruminants) avoid due to the prohibitive amount of energy (e g. in ruminating) and time

(e g. in processing) involved (Berger, 1986). According to Berger (1986), however, one drawback of this type of diet is the inability to maintain high population densities on severely deprived areas. Regardless, in relation to all 'true' horses (modern and ancient), the retention of effective physiological (e g. gut anatomy) as well as behavioural (e g. feeding patterns) strategies proves decisive when it comes to the potential for survival in demanding habitats such as the steppes and semi-deserts.

Daily and seasonal requirements

All horses, wild or domestic, have general requirements which include a fresh water source, shelter in some form, cover from wind in severe weather and a good food supply (Nowak, 1991; Duncan, 1992). If these requirements are not met, horses can suffer consequences such as lower fecundity and in extreme cases death. For example, van Dierendonck and Wallis de Vries (1996) suggest that the pressures on and rarity of water holes which kept Przewalski's horses from their water sources could have contributed to their ultimate extinction in the wild. This illustrates that water availability contributes to determining the ranges of equids such as horses and zebras because their physiology requires them to drink regularly (Duncan, 1992; Mohr, 1971). When water resources are scarce, some horses are physiologically capable of eating snow in winter (Guthrie and Stoker, 1990; Grzimek, 1975).

Horses are sensitive to the weather and thus require adequate shelter. They can cope with cold dry weather; however, when it is rainy, windy or sunny they take measures to shelter themselves. Often horses can be seen adopting a "windbreak" posture with their rear to the wind and heads down (Baker, 1993). Also, Roddis and Wakefield (1997) relate recent observations of a group of free-living Przewalski's horses which point to wind speed and wind chill factors as being key influences on shelter-seeking behaviour. Additionally, to avoid the hot sun they will seek shade (e g. near available trees, banks or hollows) (Rees, 1993b; Baker, 1993), while the feral horses of the Granite Range, Nevada will shelter in ravines and juniper forests to escape snowfall (Berger, 1986).

The forage requirements of equids are not as limiting as one might think. Horses prefer grasses as the main component of their diet; however, as a supplement they will take some browse. Duncan (1992) notes that horses prefer the green rather than the dead tissues of plants and will go to the extreme of wading into belly-deep water to obtain them. Similarly, Baker (1993) notes the Exmoor pony's fondness for the leaves

and flowers of the riverside-dwelling *Montbretia* (a member of the Iris family) in the summer. With regard to supplemental foods, both Bökönyi (1974) and Mohr (1971) note that Przewalski's horse in the wild used the roots of wild rhubarb (*Rheum leucorhizum*) as well as the bulbs of small tulips (*Tulipa uniflora*), whereas Feist and McCullough (1976) note the use of marsh grasses, reeds, forbs and roots of the milkvetch (*Astragalus sp.*) by feral horses on the Pryor Mountain Wild Horse Range, USA.

Since many free-living horses live in unpredictable environments, flexibility in their feeding behaviours is a necessity. This is exhibited not only in daily, but also in seasonal intake. For instance, in field studies of Exmoor (Baker, 1993; Gates, 1981) and New Forest ponies (Tyler, 1972), a seasonal variation in diet is stressed. Each season, the grass species intake is supplemented in varying proportions by browse such as gorse, heather, rushes and bracken. For example, Exmoor ponies were observed to take more gorse in winter than in any other season, presumably providing the animal with an extra source of energy (Baker, 1993). In more extreme environments, ponies living by the sea in Scotland supplement their spring and autumn diets with seaweed (Baker, 1993). Tyler (1972) observes a marked use of woodland habitats during autumn to spring, providing leaves and shoots of both oak and beech and even acorns. Recently, more evidence of seasonal variation in diet has been documented in free-living Przewalski's horses in Britain by T.A. Woodfine (Roddis and Wakefield, 1997).

1.2.7 Social organization and behaviour

Both Kingdon (1979) and Woodward (1991) emphasise the social and behavioural responses of horses and other equids to their environments. In general, there are two types of recognized equid social systems: 1) non-territorial, year-round, coherent family and bachelor groups (bands); and 2) territorial, seasonal, loosely organized groups (Klingel, 1974; Duncan, 1992). Free-ranging plains and mountain zebras and 'true' horses exhibit the first type of organization in which family groups consist of one stallion, his mares (c. 1-6 in number) and their offspring (i.e. harems); and bachelors form groups composed of young colts and older stallions. The territorial social system is displayed by Grevy's zebra and the asses in which some males defend territories for mating purposes and bachelors and mares form non-territorial groups. Both systems have their own distinctive advantages within their respective habitats. For example, MacFadden (1992) notes that equids forming coherent, stable groups

living in dry, highly seasonal and climatically changeable regions may have higher reproductive rates. Duncan (1992) stresses that animals adhering to one system do not normally "switch" to the other when faced with a moderate change in habitat. On the other hand, this does not mean that animals cannot adapt their normal social system to the prevailing conditions. Woodward (1991) provides several examples supporting this idea, one of which cites feral horses on Assateague Island, USA, abandoning the harem system during the winter when resources are limited. Furthermore, Monard and Duncan (1996) present evidence of Camargue horses in France changing from a "domestic type" of social organization to a "near-natural" one after four years as a free-ranging herd.

Observations of free-ranging New Forest and Exmoor ponies, Camargue horses, mustangs, and Przewalski's horses seem to support the theory that 'true' horses prefer to adopt a typical harem polygynous social system (Tyler, 1972; Gates, 1981; Monard and Duncan, 1996; Berger, 1987; Boyd and Houpt, 1994). A population (i.e. the herd), usually consists of bands of various types, each band numbering from 5 to 20 or more individuals, depending upon the circumstances and extent of management (Nowak, 1991). Like zebras, horses may periodically gather in large numbers on areas of evenly distributed rich resources, all the while maintaining band independence (Olsen, 1989; Kingdon, 1979). Group cohesion is an essential part of the lives of herd-dwelling horses. Rees (1992, 1993b) accentuates the horse's need to belong to a group and the importance of bonding within the group. Often, individuals maintain long-term relationships with other members of their group that can last a lifetime (Rees, 1993a; Boyd and Houpt, 1994).

Harem-dwelling equids tend to utilize large, overlapping home ranges, their daily activities (e g. grazing, resting) taking place in "core areas" with "extended localised movements" often occurring seasonally (Gates, 1979, Delany and Happold, 1979). Berger (1983a, 1986) mentions that the Granite Range feral horses have discrete winter and summer ranges, lying at lower and higher altitudes respectively. Also, Gates (1979) finds that Exmoor pony herds on Withypool Common seasonally vary the overlapping of their home ranges depending upon the social relationships (i.e. age, ranking) between the stallion of each band. Furthermore, both Tyler (1972) and Roddis and Wakefield (1997) cite observations of seasonal changes in the behaviour of free-ranging horses with respect to daily activities (e.g. increased time spent resting in summer).

Intra-band activities assist the observer in understanding relationships between members Evidence suggests that it is the 'dominant' mare who leads the family group in its daily activities and movements; however when the group is threatened, the stallion protects from the rear or side of the fleeing band (Rees, 1993a, Klingel, 1974). Common to all polygynous harem-forming ungulates (e.g. South American camelids, horses) is the dispersal behaviour exhibited by juvenile/subadult animals. In his study of feral horses in Granite Range, Berger (1987) notes that both sexes at about two years of age emigrate "voluntarily" from the natal band to join other bands; the males commonly joining bachelor groups and the females commonly joining other family groups. Both seem to gain benefits by dispersing in this way. The young males integrate themselves into an all-male group in which they learn certain skills (e.g. fighting) that will assist them in obtaining females, and eventually their own family band (Berger, 1987). Females, on the other hand, may decrease the occurrence of inbreeding by emigrating to bands with unrelated males (Berger, 1987; Monard and Duncan, 1996).

1.2.8 Mortality

Free-living horses probably suffer higher mortality than 'true' domestics because they have to contend with additional pressures and stresses imposed on them by their immediate environment without assistance from humans. Just as horses living in high altitude areas must deal with heavy snowfalls and food shortages, horses surviving in hot climates must cope with droughts (Berger, 1983a; Olsen, 1989). Presently, the effects of predator pressure on free-living horse herds are not well documented, although Duncan (1992) suggests that both predation and "social factors" are important regulators of equid populations. Data does, however, exist relating to modern predation of wild equids by carnivores (e g. hunting of adult zebras in Africa by wild dogs, *Lycaon pictus*: Malcolm and van Lawick, 1975). Since the African large predator 'guild' is similar to that of Late Pleistocene Eurasia (i.e. wild dogs = wolves, *Canis lupus*) this provides a suitable modern analogy.

Some of Duncan's (1992) regulatory "social factors" relate to the differences between the sexes. For example, within a herd, females and males are expected to have unequal mortality. Under normal circumstances, males incur a higher mortality due to the costs of their behaviour, from dispersing as a subadult to defending the family group as a stallion (Berger, 1983b, 1987). However, when environmental pressures are

great (e.g. droughts, extreme temperatures) female mortality can increase because gestation and lactation require relatively more energetic expenditures under such conditions (Berger, 1983b). Additionally, since most free-ranging horses live in marginalized sub-optimal habitats, the effects of human (e g. agriculture, industry) and/or livestock pressures are mortality factors which need recognition and documentation.

In aiming for re-introductions of wild horses into their former ranges, researchers must attempt to understand how to either control or decrease 'unnatural' mortality factors such as those mentioned above. However, Duncan (1992) stresses that these pressures may be genetically moulding more adaptable individuals and populations in the process. Ultimately, further studies of free-ranging equids are necessary to help maintain a database from which essential survival information can be extracted. The actual behavioural and physiological information that will eventually assist in managing species in the wild can also aid in understanding the ecology of extinct wild types (e.g. Late Pleistocene horses) more completely.

Chapter Two

Taxonomy and Relationships of Extant and Extinct Forms including a Review of the Origins of Domestic Horses

2.1 Introduction

The taxonomy of the Eurasian horse is muddled. This is illustrated by the use (in many cases, overuse) of a wide range of species and subspecies names for Late Pleistocene/early Holocene (table 2.1) and recent wild horses (table 2.2), and even domestic horses. Many authors do not heed Mayr's (1963) warning that "the subspecies is merely a classificatory device" and not "a unit of evolution". With this in mind, an attempt has been made below to disentangle and clarify the available nomenclature. Never before has one document embraced such a wide-ranging survey of taxa which includes modern domestic and wild horses as well as their wild and early domestic ancestors (i.e. Late Pleistocene and early Holocene horses).

Because the current study encompasses a relatively short period of time (i.e., 15,000 years), multiple references to species names will be kept to a minimum in order to avoid confusion. However, Mayr's (1963) definition of a species as a population or populations which vary geographically and which can "actually or potentially" interbreed, being reproductively isolated from other populations, is relevant here.

Instead, subspecies names take precedence in discussions of Eurasian fossil and sub-fossil horses. According to standard usage, subspecies are groups of local populations within a species that differ morphologically from other population groups and inhabit a geographic subdivision of the range of the species (Mayr, 1963). The subspecies occurring at the type locality of the species itself should be called the nominate subspecies, and a type specimen (i.e. holotype) at the type locality must be available for the subspecies to be considered valid (Groves, 1991).

Table 2.1. Taxonomy of Late Pleistocene and Holocene Wild Horses

PERIOD	N., S.-W. & C. EUROPE	E. & S.-E. EUROPE	ASIA	NORTH AMERICA
MID-LATE HOLOCENE (Late Mesolithic/ Neolithic/Bronze Age to Recent)	*E. f. sylvestris* v. Brincken,1828 *E. f. lusitanicus* Uerpmann,1990 *E. c. nehringi* Duerst,1908 *E. juvillacus* Bravard	***E. f. ferus* Boddaert,1785 (=Steppe Tarpan)** *E. f. scythicus* Radulescu & Samson,1962	***E. f. przewalskii* Poliakov,1881 (=Przewalski's Horse)**	
LATE GLACIAL/EARLY HOLOCENE (c. 15,000-8,000 BP)	***E. ferus* Boddaert,1785** ***E. f. solutreensis* Nobis,1971(dwarf form)** *E. c. arcelini* Guadelli,1986	***E. f. gmelini* Antonius,1912 [from Sungir (="Tarpan")]**	***E. f. przewalskii* Poliakov,1881 (="Przewalski's Horse")**	
LATE PLEISTOCENE (Early to Middle Weichselian) (pre- c. 15,000 BP)	***E. ferus* Boddaert,1785** *E. spelaeus* Owen,1869 *E. c. gallicus* Prat,1968 ***E. f. solutreensis* Nobis,1971** *E. cazurroi* Cabrera Latorre	*E. scythicus* Radulescu & Samson,1962 *E. spelaeus cibinensis* Samson ***"E. f. ferus"** Nobis,1971 (from Mezin)	*E. tscherskii* Brauner,1936 *E. uralensis* Kuzmina,1985 *E. c. lenensis* Rusanov *E. c. fossilis* v. Meyer *E. przewalskii* - used elsewhere	*E. lambei* Hay,1917
LATE MIDDLE PLEISTOCENE to LATE PLEISTOCENE	***E. ferus* Boddaert,1785** *E. c. germanicus* Sanson,1869/73 *E. germanicus* Nehring,1884 *E. remagenensis* Skorkowski, 1938 ***E. r. remagensis* Nobis,1971** **!*E. adamiticus* Schlotheim,1820**	*E. c. latipes* Gromova,1949/55 ***E. remagensis latipes* Nobis,1971 (from Mezin)** *E. transilvanicus* Teodoreanu	*E. dalianensis* Zhow,Sun, Xu & Li,1985 *E. c. orientalis* Rusanov	

BOLD = priority names as used in this study; non-BOLD = junior synonyms used or noted in literature; * = as used by Nobis (1971); ! = nomen nudum; arrow = indicates possible area of transition (after Uerpmann, 1990)

Sources: Forsten (1986, 1988); Forsten and Ziegler (1995); Groves (1974, 1991); Nobis (1971); Uerpmann (1990)

Table 2 2 Taxonomy of the 'True Horses'

GENUS	SUBGENUS	SPECIES	SUBSPECIES & SYNONYMS
Equus	*Equus* Linnaeus,1758 (WILD HORSES)	*ferus*	*E. f. ferus* Boddaert,1785 **Steppe or Plains Tarpan** (Extinct c.1900) >>Synonyms: *E. ferus*; *E. c. equiferus* Pallas,1771/6; *E. gmelini* Antonius,1912; *E. tarpan* Pidoplicko,1951; *E. p. gmelini* Heptner,1955 *E. f. sylvestris* von Brinken,1828 **Forest Tarpan** (Extinct) >>Synonyms: *E. g. silvatica* Vetulani,1927; *E. p. silvaticus* Vetulani,1928 *E. f. przewalskii* Poliakov,1881 **Przewalski's wild horse** (Extinct? in wild c.1960) >>Synonyms: *E. przewalskii*; *hagenbecki* Matschie,1903; *typicus* Hilzheimer,1909; *gutsenensis* Skorkowski,1946 ; *E. p. przewalskii* Heptner,1955; probably *equuleus* Smith,1841
	(DOMESTIC HORSES)	*caballus*	*E. caballus* Linnaeus,1758 **Domestic horse**

Sources. Clutton-Brock (1992a), Corbet (1978); Duncan (1992); Gentry *et al.* (1986); Grizimek (1975); Groves (1994); Groves and Willoughby (1981); Wilson and Reeder (1993)

2.2 Review of the taxonomy of extant and extinct horses

2.2.1 Modern domestic horses (*Equus caballus* Linnaeus,1758)

The naming of domestic animals is a source of much debate (e g. Groves, 1991; Groves, 1995; Uerpmann, 1993; Gentry, Clutton-Brock and Groves, 1996). The problems arise when taxonomic names for domestics are used when researchers are naming extant and extinct wild subspecies. On the one hand, they are correct in assuming that the domestic species names have priority over the use of wild species names because they were coined earlier; and on the other hand, they may be misguided in assuming that a domestic animal can be a nominate subspecies, let alone a separate species. For example, the domestic horse *Equus caballus* was named by Linnaeus in 1758, almost 30 years before the wild horse was named *Equus ferus* by Boddaert in 1785; thus the name *E. c. przewalskii* for the wild Przewalski's horse was once considered valid. At this point it must also be mentioned that many authors mentioned in the current work also misuse '*caballus*' as a species name to designate hypothetical wild and domestic subspecies. However, Gentry *et al.* (1996) currently propose that, to avoid confusion, wild taxa should be named using the first available names based on wild specimens. Therefore, in the current study, all truly Late Glacial to modern wild horses will be referred under the species name *E. ferus*, and for convenience all modern domestic horses will be referred to as *E. caballus* following the proposals of these authors.

The word '*caballus*' refers to the hollow hoof mark (*a cavo pede*) left as an imprint when the horse walks. In support of the use of *E. caballus* for domestic horses is the fact that when Linnaeus assigned this name to the true horses he did so with a 'type animal' in mind. As the 'type animal' of *E. caballus*, Linnaeus chose the Norwegian horse (or Fjord pony) which interestingly exhibits both wild and domestic phenotypic traits (e.g. dun colouring with dorsal stripe down back and a long hanging mane with a forelock, respectively) (Willoughby, 1974). Many of the characteristics mentioned by Linnaeus seem to conform to the typical caballoid horse; however, it must be stressed that a cautious approach be taken when comparing this 'type animal' with other domestic and wild horses because Linnaeus chose to base the scientific name for the horse on a specific domestic breed. Bearing this in mind, it seems correct that only domestic animals can and should bear the species name '*caballus*', if only to differentiate them from their wild counterparts, whatever their phylogenetic

relationships. The complicated issue of domestication and domestic versus wild animals will be dealt with in chapter 6.

2.2.2 Recent wild horses (*Equus ferus* Boddaert,1785)

Because domestic horses (both captive and free-ranging) are so widespread in modern times, this tends to overshadow the existence of their wild predecessors. Therefore, the current study aims to survey these predecessors and track their 'evolution' through to recent wild and domestic horses. The only two subspecies of true wild horse known to have survived into recent times (i.e 19th and 20th centuries) are the tarpan (*Equus ferus ferus* Boddaert,1785) and the Przewalski's horse (*Equus ferus przewalskii* Poliakov,1881).

Several authors cite historical references to wild horses. For example, Groves (1994) notes that Herodotus (c. 485-425 BC), the Greek historian and traveller, spoke of "wild white horses" living in what is now eastern Europe, and even the Romans are thought to have mentioned them. However, European 'wild' horses were first formally described by G. S. Gmelin in the late 18th century (Groves, 1994; Clutton-Brock, 1992a). Indeed, Zeuner (1963:311-13) translates Gmelin's description in detail, providing a rare glimpse of these recent supposedly true wild horses, thought to be tarpans, in their wild habitat. In 1769, Gmelin observed small "mouse-coloured" horses with "short, frizzly manes" on the steppe near Bobrovsk. Based mainly on this description, Boddaert (1785) named the tarpan *Equus ferus* almost one century before the Przewalski's horse was first formally described (Groves, 1994). Therefore, the tarpan is considered the nominate subspecies for the *ferus* species, making its scientific name *Equus ferus ferus*. However, it is sometimes known as *Equus gmelini* Antonius,1912.

*The tarpan (*Equus ferus ferus *Boddaert,1785)*

The tarpan or extinct eastern European wild (or feral) horse has often been compared to the Przewalski's wild horse The tarpan (the Turkoman word for wild horse (Clutton-Brock, 1992a)) was slightly smaller than the Przewalski's horse, measuring 130-145 cm high at the withers, and it is thought to have had a light yet strong build, short head, a broad flat forehead, a ram nose and small pointed ears Its colour is known to have been mouse-grey or ash-grey with a black stripe along its spine, its mane to have been short and erect, and its tail short and covered in long dark

hairs (Bökönyi, 1984). Even though remains from various eastern European early Holocene sites have been identified as 'tarpan', Forsten (1988) insists that the recent tarpan "lacks unequivocal fossil documentation". This aside, in the late Holocene, the tarpan is said to have been numerous on the steppes of the Ukraine and most of eastern Europe until extensive hunting led to its extinction in the wild by the end of the 19th century (Bökönyi, 1984; Heptner, 1961). A few animals are known to have survived in captivity in eastern Europe for at least a decade into the 20th century. The most famous of these animals are the Shatilovski or Cherson tarpan and the Dubrowka or Taurian tarpan. After its capture in 1866 on the Zagradoff steppes, north of Crimea, the Cherson tarpan spent several years in Moscow Zoo, and can be seen in a well-known photo of 1884 (see fig. 2.1). The Taurian tarpan (an eight-year-old gelded male), also known as "Tarpan 521", was the last true tarpan, which died in captivity in 1918 and whose skeleton and skull can now be found in the collections of the Zoological Institute, St. Petersburg (Groves, 1994; Nobis, 1971; Willoughby, 1974).

Some authors tend to disagree with the use of the species name *ferus* because of its confusing derivation. In reference to the last surviving tarpans, Mohr (1971) and others (e.g. Nobis (1971)) consider these animals to have been the descendants of feral domestic horses or at the very least tainted with "domestic blood" (Mohr, 1971). Like Clutton-Brock (1992a), the present author is not wholly convinced about the status of these so-called wild animals described by Gmelin and others. Even he found feral horses and "hybrids" running with the wild tarpan herds (Zeuner, 1963). On the other

Fig. 2.1. A Russian photograph of the Cherson tarpan in Moscow Zoo in 1884. (from Boyd and Houpt, 1994).

hand, Heptner (1961) and Heptner *et al.* (1961) contend that the tarpans (including even the most recent specimens) were a group homogeneous in colour, size and shape, and thus a "species of genuine wild horse" As will be seen later, the homogeneity of wild horses is an important feature separating wild from domestic animals.

It must be noted that the above taxonomic and phenotypic descriptions of the tarpan correspond only to the so-called plains or steppe tarpan and not to Brincken's and Vetulani's forest tarpan (*Equus sylvestris* v. Brincken,1828 and *Equus gmelini silvatica* Vetulani,1927, respectively). According to Heptner (1961) and Groves (1991) it was supposedly smaller (i.e. shorter face and limbs) and lived in the forest areas of South-west Byelorussia, Lithuania, western Ukraine, Poland and Germany in the 17th to 19th centuries. To illustrate the confusion surrounding the origins and distribution of both forms of tarpan, Groves (1991) notes that the Taurian tarpan described above had originated from Prussia which suggests that it could be a forest tarpan instead of a steppe one. However, Vetulani (1927) himself classes "Tarpan 521" (i.e. the Taurian tarpan) as a steppe tarpan in morphological comparisons with other horses including the Polish Konik, a modern native pony which he considers to be directly descended from the wild forest form. To complicate matters even further, Janikowski (1942) notes that Vetulani's '*silvatica*' is based on this "small domesticated peasant horse" (i.e. the Konik). As will be seen later, this contentious practice of naming wild species/subspecies based on domestic animals is repeated many times in discussions of domestic horse origins. However, despite the confusion between steppe and forest forms, "Tarpan 521" remains the only complete skeleton of a supposedly wild tarpan and this is important when morphological comparisons are made between the tarpan, modern domestics and the Przewalski's horse in the current study (see chapter 5).

*The Przewalska's horse (*Equus ferus przewalskii *Poliakov,1881)*

The Mongolian or Asiatic wild horse (takhi) is named after Colonel N. M Przewalski (1839-1888), the Russian explorer who rediscovered the horse in Central Asia. Even though Przewalski never actually caught his own horses, he presented a skin and skull to the Zoological Museum in St. Petersburg which had been given to him previously as a gift. The museum's conservator, I. S. Poliakov, examined the specimens and from these established a new species of wild horse which he decided to name after Colonel Przewalski, calling it *Equus przewalskii* in 1881 (Bokónyi, 1974) Even though this specimen is known to be from a juvenile subadult animal (i e. 15

months old), and not a three year old as Poliakov (1881a, 1881b) suggests, it is still considered to be the type specimen of the Przewalski's horse However, it must be noted that today a more acceptable practice is to base species or subspecies on fully adult animals as type specimens.

The general description of this wild horse is given as an animal with withers height of 138-146cm for stallions and 134-140cm for mares, a stocky build, large muzzle, a long head in proportion to its trunk, and a thick neck. The Przewalski's horse is most commonly light to yellow bay or dun in colour, although Mohr (1971) notes that many of the wild-caught horses included animals of a darker or redder bay colour. They possess the characteristic dark eel-stripe down their backs often accompanied by cross-striping along the shoulders; a muzzle which is light in colour (i.e. mealy muzzle) as is the colouring around the eyes; a short upright mane unlike a domestic horse's long, hanging one; and a dark mane and tail, the tail differing again from domestic horses in having shorter upper hairs (i e. the dock) than lower ones (Bökönyi, 1984; Groves, 1994) (see figs. 1.2 and 2.2). Many of these characteristics are often quoted by authors as being primitive phenotypic traits which can still be seen in some domestic breeds. For example, many supposedly 'primitive' pony types/breeds including the Exmoor, Highland, Fjord, Mongolian, Polish Konik, and Portuguese Sorraia have an eel-stripe down the back, leg stripes, or a mealy muzzle (see fig. 2.3). It is possible that some of these traits, namely coat colour/pattern and eel-stripe, have been selected for and that their presence in certain domestic breeds may not signify a close relationship with a primitive ancestor, but serve only as a reminder of the powerful influence of selection and breeding

Problems have arisen in naming the wild Przewalski's horse. Originally, this wild horse had been considered an independent species, and was named as such, *Equus przewalskii*, by Poliakov in 1881. However, Bökönyi (1974) relates Nobis' opinion that the Mongolian wild horse should be considered as a subspecies of the Late Pleistocene-early Holocene Eurasian wild horse, and since the latter's oldest name is known to be *Equus ferus*, it should therefore be called *Equus ferus przewalskii*. Furthermore, both Mohr (1971) and Groves (1994) note that no discrete type locality is given for the type specimen of *E. przewalskii*, thus causing taxonomic confusion in the naming of regional and phenotypic variants. The many junior synonyms that have been offered for this subspecies are listed in table 2 1.

Fig. 2.2. The phenotypic traits of the Przewalski's wild horse as displayed by individuals at Whipsnade Zoo, England. Top: the mealy muzzle, dark mane, legs and tail; bottom: the dorsal or eel-stripe.

Fig. 2.3. The phenotypic traits of two native pony breeds: left, the Exmoor pony; right: the Fjord horse. Both individuals shown display a mealy muzzle. (from Baker, 1993 and The Norwegian Fjord Horse Registry: http://nfhr.com).

Bökönyi (1974) considers the Przewalski's horse to be a small-sized descendant of larger wild horses, noting the fact that they have large teeth in proportion to their skull. According to Bökönyi, teeth do not behave as "plastically" as the skull and postcranials do, and therefore are slow to respond to environmental changes. Forsten (1988) cites these large Eurasian forms as the Late Pleistocene Tscherski's horse (known as *E. tscherskii* Brauner,1936 or *E. lenensis* Rusanov) found at Siberian sites such as Kolyma, Jana, Selerikan, and Yakutia. An alternative, although unlikely hypothesis for the origin of the Przewalski's horse is that its ancestor may be a representative of a late immigrant from North America, the Yukon horse (*Equus lambei* Hay,1917) (Forsten, 1988). Furthermore, Nobis (1971) regards the extant Przewalski's horse as an eastern population of a more widespread Eurasian group which has become dwarfed due to climate change and isolation; however, he mentions the alternative possibility that this subspecies could be morphologically adapted especially for living in an arid steppe environment. In agreement with this alternative hypothesis, van Dierendonck and Wallis de Vries (1996) cite Dulamtseren's (1993) ideas of the "takhi as a well-adapted, arid-steppe-dwelling equid". This illustrates that the study of the Przewalski's horse's morphology has become an important part of the study of wild horses in relation to their environment. In the current study, its skeletal elements serve as the standard 'type' to which comparisons can be made, whether they be to Eurasian extinct wild horses or extant domestic ones.

2.2.3 Late Pleistocene wild horses

*The caballines (*Equus ferus*)*

The naming of wild species and subspecies which did not survive the Pleistocene or at least did not survive into historical times is even more muddled, confusing and complicated. There are at least three species names available for the Late Pleistocene Eurasian wild horses and several subspecies names. The problem arises when authors do not follow nomenclatural rules and use these names interchangeably as will be seen later in this chapter. Nobis (1971:42) admirably attempts to sort Pleistocene/Holocene wild and early domestic horses taxonomically, chronologically and geographically. However, in this study, table 2 1 aims to highlight and extend these areas further while focusing more specifically on the Late Pleistocene to early Holocene. Until now, a diagram like table 2.1 had never been constructed using 'magnification' on such a fine

timescale. The main objective here is to clear up the confusion that exists by identifying priority names while providing examples of junior synonyms for named (type) material from the regions of Eurasia, east to North America. A more thorough review of the chronological, geographical and morphological considerations regarding the taxa in table 2.1 will be made in chapters 4 and 5.

According to several authors (e.g. Nobis, 1971; Forsten, 1988; Eisenmann, 1988), during the Early-Middle Weichselian of western and central Europe, a significant shift took place between the so-called "ancestral form", the medium-large size *E. ferus*, the name accepted by the present author (also called *E. germanicus* Nehring,1884 or *E. remagenensis* Skorkowski,1938 from the type site of Remagen, Germany) and the medium-small size *E. ferus* (also called *E. c. gallicus* Prat,1968 or *E. f. solutreensis* Nobis,1971 from the Gravettian (or "magma de cheval") levels of Solutré, France). The Late Weichselian (i.e. Late Glacial or Magdalenian) saw a further reduction in size to a small form known as *E. c. arcelini* Guadelli,1986 from the Late Magdalenian levels of Solutré (also known as *E. f. solutreensis* Nobis,1971 [dwarf form] from the Magdalenian sites of Andernach and Lausnitz, Germany). At this point, it must be noted that another taxonomic name is used widely to designate '*gallicus*' horses. According to Forsten (1988), the older synonym of *E. spelaeus* Owen,1869 was used by Samson (1975) to describe Middle and Late Weichselian horses of Romania. However, this affinity with '*gallicus*' does not seem to agree with the work done in the present study which indicates that Owen's '*spelaeus*' of Bruniquel (or Courbet), France (the type material/site) is more closely linked, both chronologically and morphologically, to '*arcelini*' of Late Glacial north-west Europe. For a further discussion the Bruniquel horses in relation to these issues see chapters 4 and 5.

Size transitions are also thought to have occurred in eastern and south-eastern Europe and Asia, but under different environmental/climatic conditions and sometimes in unexpected directions. For example, Nobis (1971) notes a size change from the small form, "*E. f. ferus*" back to the medium form, "*E. f. gmelini*" at the eastern European Late Pleistocene (c. 25,000 years BP onward) sites of Mezin and Sungir, respectively (see table 2.1) However, he has received criticism (e g. Samson, 1975) for making crucial errors of site-chronology and taxonomy, using '*gmelini*' and '*ferus*' for taxa which differ in size from the tarpan. Despite these problems, Forsten (1988) praises his recognition of a single small species uniform in size, proportions and

morphology in the Late Pleistocene/Holocene as well as his comparison of both eastern and western fossils of this period (see review below).

In her 1993 paper, Forsten highlights the problems associated with delimitation of species and their identification in fossil samples. According to Forsten (1993), "so far, there are no morphological characters which can be used in multivariate analyses which objectively delimit and/or differentiate caballoid species". This serves to complicate the above 'simple' and generalised Late Pleistocene transition within *E. ferus* from '*germanicus*' to '*arcelini*' (see table 2.1). Forsten (1993) sees a lack of pattern in morphology geographically which "makes erection of species and subspecies of these horses rather subjective". Confusion and contradiction amongst researchers is evident concerning this separation and naming of species/subspecies. For example, Forsten and Ziegler (1995) note the Early Weichselian (> 30,000 BP) '*germanicus*' horses of Villa Seckendorff, Germany as "distinct" from smaller forms such as Late Weichselian (< 30,000 BP) '*gallicus*' of Solutré; while on the other hand, Eisenmann (1991) considers '*germanicus*' and '*gallicus*' (e.g. from Remagen, Germany and Jaurens/Camiac, France, respectively) to be the same "morphotype" (Eisenmann's Type I), whereas latest Weichselian (< 16,000 BP) '*arcelini*' (e.g. from Solutré, France) (Eisenmann's Type II) differs from '*gallicus*' in proportions of teeth and metapodials. First, even though Forsten (1993) has criticised the subjective naming of species/subspecies, both she and Eisenmann (above) persist in using these taxonomic 'tags' in their more recent works, albeit with some reservations (e.g. Forsten and Ziegler, 1995). Second, all this evidence suggests that by the latest Pleistocene only one species of caballine horse (i.e *Equus ferus*) was present in north-west Europe. On the other hand, Forsten (1993, 1988) provides rare evidence of sympatry of morphologically similar, large and small forms at Late Pleistocene European sites such as La Adam Cave, Romania. She believes that this is the only "direct" evidence for the presence of multiple species. However, the present author is sceptical about such claims since fossil material from the relevant Late Pleistocene continental European sites is poorly dated (e g. radiometrically) even though the stratigraphy may be sound. For a thorough review of these problems see chapter 4.

The stenonines (e.g. Equus hydruntinus *Regalia, 1904)*

Another equid can be encountered, although rarely, among Middle to Late Pleistocene faunas of Eurasia, and it is the only known stenonine to be sympatric with

the caballines of the period A "companion" to '*E. germanicus*', *E. hydruntinus* occurred with both temperate and cold faunas, becoming extinct as late as the Neolithic to Copper Age in southern Spain and eastern Europe (Forsten and Dimitrijevic, 1995; Forsten and Ziegler, 1995; Azzaroli, 1992). *Equus hydruntinus* is often described as an "ass" (e g. Kurtén, 1968) due to its slender limbs; however, Forsten and Ziegler (1995) note that it differs in tooth morphology from extant asses and therefore is not as closely related to them as first assumed. Although its presence is well-documented in southern Europe throughout the Late Glacial, evidence from the present study suggests that *E. hydruntinus* is absent from Britain and probably continental north-west Europe during this period. However, Forsten and Ziegler (1995) note that due to its scarcity in most samples this can only be considered negative and not conclusive evidence for its absence. This must be taken into consideration due to the presence of *E. hydruntinus* at sites in Britain, Germany and France during the late Middle Pleistocene (e.g. Swanscombe, Villa Seckendorff and Lunel Viel: Forsten and Dimitrijevic, 1995; Forsten and Ziegler, 1995).

2.2.4 The question of ecotypes

Animals are a product of their environment, in the sense that their environment influences which adaptations they will acquire. As an alternative to the subspecies concept, some authors, in their discussion of wild horse types, comment on 'races' as 'ecotypes'. Mayr (1963) highlights Turesson's (1922) idea of "the adaptive nature of geographic variation" encompassed in the ecotype concept which aims to expand the "purely morphological definition of species" to include ecological considerations (e.g. behavioural modifications). In biological terms, ecotypes are varieties of animals which respond genetically to certain kinds of environments, thus acquiring distinctive characteristics which enable them to successfully survive in those environments. This idea of ecotypes makes it possible for racial types to coexist in close proximity and to evolve independently in discontinuous areas (Zeuner, 1963; Mayr, 1963). On the basis of this idea, Zeuner describes the horse ecotypes "tentatively assumed to have existed" during the Upper Palaeolithic of Western Europe as follows: the tundra ecotype, the grassland ecotype, the loess-steppe ecotype, and the forest ecotype. These ecotypes are based on the assumption that these habitats did exist during the Late Pleistocene-early Holocene of central and western Europe. However, because Zeuner (1963) provides no material evidence (i e type material/sites) for these ecotypes, the present author is

forced to assume that these are only hypothetical forms of "different geographical races" which are thought by Zeuner to be represented in western European Palaeolithic cave art (see below). On the other hand, Forsten (1993) suggests that ecotypes of a single species could have been present in the Eurasian Late Pleistocene as evidenced by the variable sizes of caballines present during cold and temperate climatic phases. A main aim of the current study is to thoroughly investigate the evidence for size variability of well-dated material during the British Late Glacial in particular, and to make comparisons with continental material of similar age in order to explore the temporal and geographic distribution of forms (or ecotypes), a study which Forsten emphasised was much-needed.

Lending more support to the ecotype theory is Kleinschmidt's work of 1966, cited by Groves (1991), in which the author provides a general review of Pleistocene/Holocene eastern and western wild horse groups as well as stressing the importance of climate and ecology when noting that some Pleistocene taxa are better regarded as 'ecotypes' than true species. However, Mayr (1963) criticises the ecotype theory for causing more confusion than it resolves in its replacement of the subspecies. For example, he emphasises that "ecotypes are rarely discontinuous, rarely well delimited, often polyphyletic and always full of intraecotype variability". Another problem with this concept concerns Turesson's (1922) idea that an ecotype is the "product arising as the result of the genotypical response" to a given habitat. Lister (1997) notes that an animal's response to environmental change need not be genetic. For example, many animals (e.g. horses) which are behaviourally flexible can accommodate their behaviour to fit the requirements of their habitat (see chapter 1). Also, many animals exhibit non-genetic 'ecophenotypic' modifications which are influenced by the immediate environment (e.g. climatic effects on body size); however, Lister (1997) does note that "ecophenotypic effects may be the precursors of evolutionary change" (i e. a genetic change). One of the main aims of the current study is to highlight the morphological as well the adaptive, behavioural, and habitat components of fossil horses, thus defining *Equus ferus* and its domestic progeny (*E. caballus*) more precisely, as ecological entities.

2.3 Depictions of horses in Palaeolithic art

The Palaeolithic cave paintings and portable art of south-west European caves depict horses which look very similar to the modern Przewalski's horse in that they have upright manes, mealy muzzles, the dun colouring and dark manes and tails (fig. 2.4). Additionally, Groves (1994) notes the presence of "beards" on the jawline (i e. representative of a horse in winter coat) (e.g. Niaux Caves, France) and suggests that phenotypic examples such as this are the most believable aspects of the art considering what is known of the external features of present-day wild horses. Even though Groves (1994) believes a drawing from Niaux (fig. 2.4) to be a very close likeness to the Przewalski's horse, many authors (including Groves himself) have suggested that not all the horses depicted in all the caves bear resemblance to the Przewalski's horse, and that possibly these horses are representatives of various wild 'types' or even subspecies that were present during the Upper Palaeolithic. Zeuner (1963) summarises several proposals including Breuil and Peyrony's (1924) 'Libyan', 'Celtic', 'Nordic' and 'tarpan' types at Combarelles Cave at Les Eyzies. Similarly, Nobis (1974) points out Windels' (1948) suggestion that the variation seen in the Lascaux horses is indicative of "a process of species formation" during the Late Pleistocene. However, like Nobis, Groves (1991) is sceptical about these attempts to 'create' species or types based on apparent variation. He is scathing in his criticism of Blanchard's 1964 paper in which Blanchard envisages that there were at least 18 different species of horse depicted on the walls of various western European caves. This example of an extreme case indicates that caution must be used when interpreting this form of artistic evidence which may itself incorporate stylistic differences and some degree of artistic licence in the representations of horses. However, on the hypothesis that these types did indeed exist, Mohr (1971) describes the variants as possible "local types" of the wild horses which authors from certain countries invoke when tracing the origins of their native breeds to Przewalski's horse or to a common ancestor. For example, the French deem their Camargue pony a direct descendant of these prehistoric wild horses as do the English their Exmoor pony. Most notable is the assumption by Dr. Francis Haines that the "dapple-grey" horses depicted at Pech-Merle are of the Appaloosa breed, an unlikely theory due to the fact that this breed was developed in America in the 18th century from mainly Spanish stock (Mohr, 1971, Edwards, 1993).

Fig. 2.4. Palaeolithic cave paintings. Top: a horse from Lascaux Cave, France which displays dark mane and legs; bottom: a horse from Niaux Cave, France which displays an upright mane and 'shaggy' jawline. (from Mark Harden's Artchive: http://www.artchive.com and Rich Leiszler: http://www.emporia.edu/earthsci/student/leiszler/).

Concerning the various 'types' depicted, the question inevitably arises: "Are they contemporaneous or do they succeed one other?" Epstein (1971) cites Laming's view that Pre-Magdalenian cave art of Lascaux depicts horses with elongated heads while those Magdalenian in age have "thicker and squatter" heads. However, this is a dangerous practice unless these suggestions can be substantiated by stratigraphical, radiometric and morphological evidence of remains found at the site concerned.

Here, for the first time, a description will be made of a horse engraving (fig. 2.5) discovered by the author in the collections of the Palaeontology Department of The Natural History Museum, London on 14 September, 1994. While studying the horse remains from the Late Magdalenian site of Bruniquel (or Courbet), France held in the Natural History Museum, a horse bone (a right fourth metatarsal [or MTIV]- number 38475) was found to have an engraved image of a horse's head in profile situated on its dorsal surface, at the proximal end. On closer examination, the image was noticed to be partly obscured by the specimen identification sticker, thus supporting the claim that it had not been noticed by previous workers.

Richard Owen first described the organic material from the 'Cavern of Bruniquel' (or Courbet) in 1869, spending an enormous amount of effort cataloguing and interpreting the horse finds. The present author is certain that the material described by Owen (1869) is the same material now housed in the NHM and identified as "*E. spelaeus* (syntype) var. A and B". A thorough review of the site's history, chronology and horse material will be given in chapter 4 (section 4.4.2).

The present author considers figure 2.5 to be a good example of a 'naturalistic' depiction of a Late Pleistocene wild horse. Its large head and forward pointing, somewhat upright mane are consistent features which are present in many depictions of this kind (Mohr, 1971). In fact, another engraving on an antler from the same site depicts a similar representation of a horse's head in profile (fig. 2.6). Although it appears that these animals had a forelock (a common domestic horse trait), Mohr (1971) cites Heck (1934) as deeming that its presence "does not mean that a wild horse is not pure bred". On the contrary, many Przewalski's horses exhibit this longer forelock before seasonal moulting (i.e. before mid-summer), due to old age or due to lack of fitness (Mohr, 1971). Thus, instead of trying to determine how many types, 'races', or ecotypes are represented in Palaeolithic art more attention should be paid to details which, if treated cautiously, can provide both ecological and perhaps behavioural information.

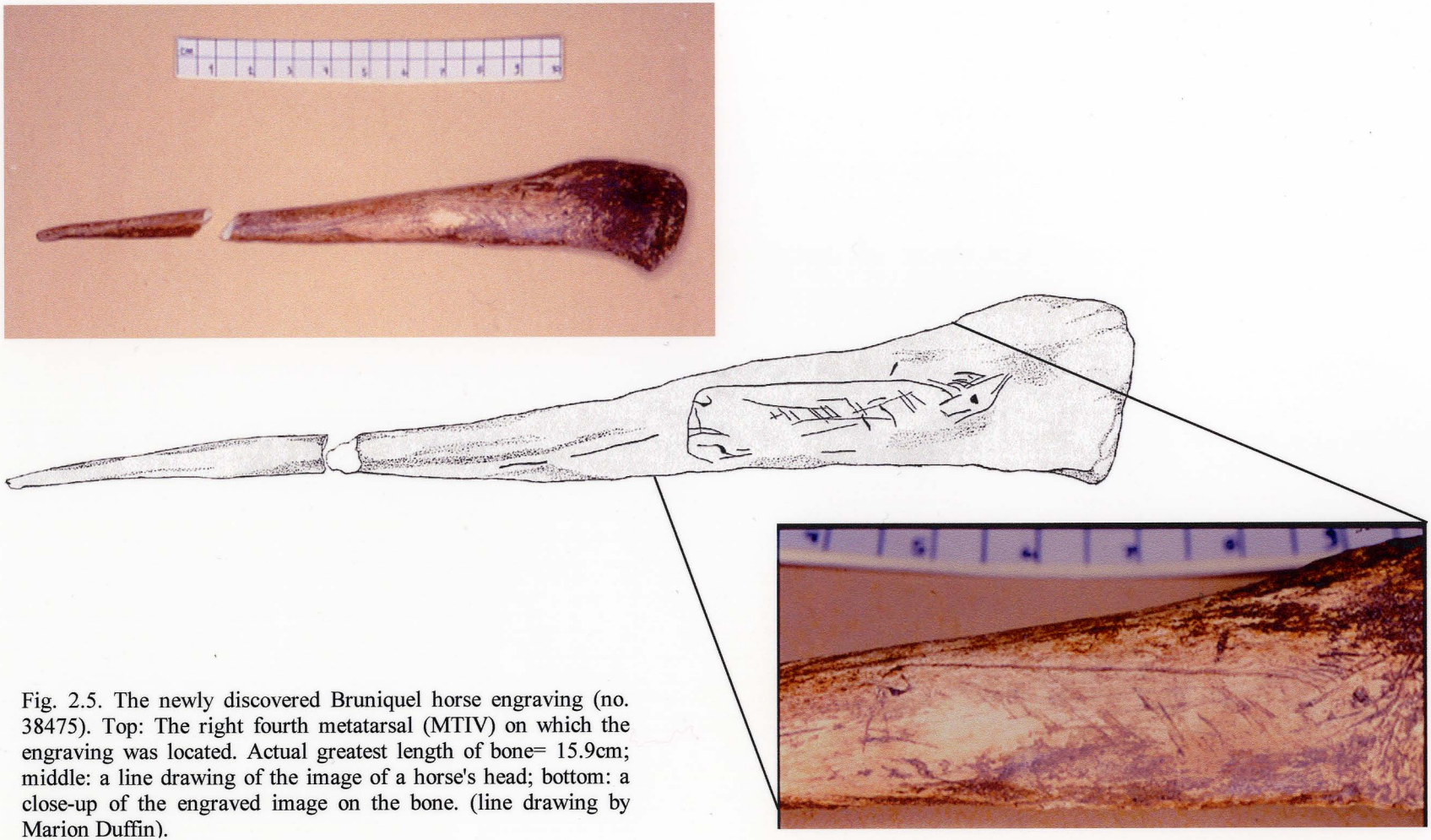

Fig. 2.5. The newly discovered Bruniquel horse engraving (no. 38475). Top: The right fourth metatarsal (MTIV) on which the engraving was located. Actual greatest length of bone= 15.9cm; middle: a line drawing of the image of a horse's head; bottom: a close-up of the engraved image on the bone. (line drawing by Marion Duffin).

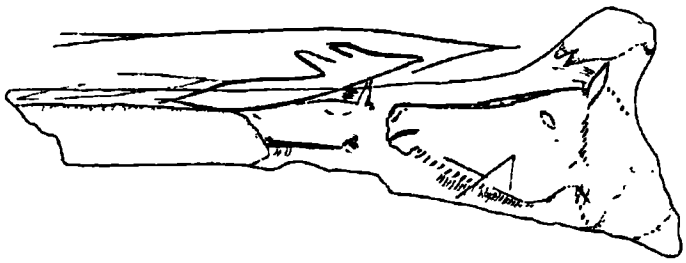

Fig. 2.6. A line drawing of a horse's head engraving on antler from Bruniquel (no. 64.12.26.742) depicting what appears to be a forward pointing forelock and shaggy jawline. (from Sieveking, 1987).

2.4 The origins of the domestic horses

During this century, numerous authors have focused their research on the origins of present-day domestic horses. These include G. Nobis, J. C. Ewart, M. Hilzheimer, O. Antonius, B. Lundholm, S. Bökönyi, J. Clutton-Brock, H.-P. Uerpmann, and both J. G. and M. G. Speed. Ever since the Przewalski's horse was rediscovered in Central Asia in the late 19th century the scientific world has been forced to question the relationships between domestic horses and their wild progenitors.

Although the Przewalski's horse figures prominently in discussions concerning origins, it is also necessary to survey the other postulated ancestors of the domestic horse in order to thoroughly investigate horse evolution. Moreover, it is necessary to bear in mind that Przewalski's horse, being extant, cannot be the ancestor of domestic horses, but at most a sister-group or a relict of an ancestor.

2.4.1 The tarpan versus the Przewalski's horse

Many questions arise concerning both the tarpan and the Przewalski's horse as individual taxa and in relation to one another. Since these two so-called wild horses are the last, and only ones to survive into the 20th century, zoologists tend to assume that the ancestors of these horses played an important role in the origin of domestic horses. Some authors believe that the tarpan has exerted the most influence in the evolution of domestics, whereas others think that Przewalski's blood is most influential. Once again, it is worth stressing that even though extant groups such as the Przewalski's horse cannot be 'true' ancestors, authors still repeatedly cite both the Przewalski's and the tarpan as such. Ewart (1905-06) mentions that Darwin was one of the earliest scientists to believe that domestic horses were descended from a single dun-coloured

more or less striped primitive stock. However, a majority of authors subscribe to the theory that domestic horses have had a polyphyletic or multiple origin (Willoughby, 1974) The theory of a monophyletic origin has been strongly contested by several authors whose theories range from domestic horses having two distinct ancestors, to each specific breed of horse having one wild ancestor of its own. The real question to be tackled is "Where do the tarpan and Przewalski's horse (as well as their own ancestors) fit into this theory of multiple origins and if they do fit in at all, how closely related are they to one another?".

Mohr (1971) believes that the nostrils and jaw are two of the few characteristics which distinguish the tarpan from the Przewalski's horse. However, in addition to metrical differences of the skull and teeth, Willoughby (1974) clearly summarises the external differences (e.g. head shape, tail length, coat colour) between the two types of wild horse. Similarly, Bökönyi (1974) does not doubt the differences in form and colouring between the two; however, he does question whether these differences are sufficient for considering the two as individual species of wild horse.

Regarding the tarpan's status, Epstein (1971) and Nobis (1971) cite Gmelin in 1769, Pallas in 1771, 1776 and 1831, Schatilov in 1861, Nehring in 1890, von Falz Fein in 1919, Gromova in 1949/55 and 1963, Heptner in 1955 and Sokolov in 1959 and 1967 as believing the tarpan of the southern and central Russian steppe regions to be truly wild; however, they also cite Radde in 1878, Anutschin in 1896, Bogdanov in 1926, Kwaschnin-Ssamarin in 1931, Herre in 1939 and Nobis in 1955 as rejecting this hypothesis, many of them regarding it as a feral or hybrid animal. The lack of uniformity of conformation (i.e. size and shape) and coat colour are seen to be factors which restrict the tarpan from being an independent species (Epstein, 1971); however, this view is contrary to Heptner's (1961) and Heptner *et al.*'s (1961) that the tarpan was a homogeneous group.

Epstein (1971), in his review of the origins of domestic horses, surveys various papers concerning the tarpan and notes that Lydekker in 1912 believed the tarpan and the Przewalski's horse to be identical On the other hand, Antonius in the same year separated the tarpan as an individual species with the name *Equus gmelini*, though later, in 1933, he relegated it to a subspecies with the name *Equus caballus gmelini*, regarding it as the ancestor of all prehistoric small horses of Europe, specifically the Bronze Age and recent ponies. Again, like the Przewalski's horse, it is not possible for the tarpan to be an ancestor. Furthermore, Nobis (1971) cites Gromova's confirmation

of the separation of the Przewalski's horse and the tarpan into "two different species" based on morphology, while Sokolov (1967) and others believe that the geographical ranges of the tarpan and Przewalski's horse were separate. However, Epstein (1971) disagrees with this view and believes that the lack of geographical separation, together with the supposed lack of conformity of the tarpan means that it is "one of several phases occurring in *Equus przewalskii* and as a manifestation of the enormous variability of this horse".

The present author is concerned that Epstein (1971) strengthens his argument against the Przewalski's-tarpan (east-west) separation by citing Antonius' (1922) assumption that a western population of Przewalski's-type horses was present at the Late Pleistocene site of Solutré. It has not yet been verified that the Przewaski's horse or its ancestor had a close relationship with the horses of Solutré or any other north-west European Late Pleistocene site. Ultimately, the recent practice of using both morphological and molecular (e.g. mtDNA) comparisons in conjunction may help to answer or at least provide new evidence on these questions (e.g. subspecific versus specific status, ancestral links). Views on these relationships including morphological comparisons between the Przewalski's horse, the tarpan and Late Pleistocene horses are dealt with in chapter 5 and molecular studies are reviewed in chapter 6.

Nobis (1974) comes to the conclusion that the enquiry into wild ancestral stocks is closely tied up with the phylogeny of the Pleistocene equids. Here, Nobis raises both palaeontological and taxonomic questions. The palaeontological question concerns the necessity for thorough studies of equid fossil and sub-fossil material which can be dated to the Late Pleistocene-Holocene in order to determine ancestry; while the taxonomic question concerns enquiries into the relationships of various types (both extinct and extant) contained within the genus *Equus* as well as types within the *ferus* species.

2 4 2 Hypothetical ancestors of domestic horses

In this century, several authors have undertaken the task of searching for and naming the ancestors of all present day domestic horses These approaches have offered numerous new names and types. Some authors work from the evidence at hand (e g. fossil and sub-fossil material) and investigate morphology in an attempt to deduce habitat preference and type. These authors are primarily interested in identifying wild 'types' which may reveal ancestral ties with domestic breeds. On the other hand, many

authors seem to have worked in reverse (i e. from domestic to wild) when proposing types and subspecies, using the enormous variability of domestic breeds as a motive for assuming the occurrence of various types within the ancestral stock. For example, Groves (1991) cites Trumler's work in 1961 which is based on work done by Speed and Ebhardt and others in which Trumler recognises 4 species of wild horses: 1) *E. complicatus* (a Przewalski's-type horse); 2) *E. abeli* Antonius,1913 (a large, heavy horse); 3) *E. laurentius* (the ponies); and 4) *E. libycus* (the Arab horse ancestor). Groves (1991) criticises this proposal of types which he calls "reconstruction of hypothetical ancestors" where one type (*E. libycus*) has been based on no fossil or recent wild specimens, a contentious taxonomic practice. Therefore, it is preferable to highlight the sound work of the many authors who have carefully scrutinised the fossil and sub-fossil material from Eurasian sites in order to suggest plausible 'types', if not subspecies (e.g. Lundholm (1947), Nobis (1971), and Uerpmann (1990)).

The wild 'types'

B. Lundholm was one of the first scientists to research the origins of domestic horses using morphological comparisons of wild horses (both fossil and extant) and early domestic horses, as well as modern domestics. While comparing the lengths of upper cheek teeth, Lundholm (1947) introduces "tooth-form diagrams" for wild horses which, he believes, show variations important enough to deem the group as being nonhomogeneous These tooth-form diagrams help Lundholm to divide wild horses into two groups: 1) a so-called western group where M3 is just as long as M2; and 2) a so-called eastern group where M3 is longer than M2 Furthermore, he declares that the western group comprises Late and Post Glacial wild horses of two forms (the larger "*Germanicus*" group and the smaller "*Microhippus*" group) from middle Europe; and that the eastern group includes a number of eastern European and Asiatic fossil horses as well as the tarpan and the Przewalski's horse (Lundholm, 1947).

Finally, Lundholm's (1947) comparative investigation of the recent Equidae led him to suggest that they have a tendency to develop into different forms in different regions (i e. ecotypes) and that this same tendency is shown by fossil forms. Lundholm (1947) explains the division of wild horses into two groups as being a product of the biogeographical environment during the Pleistocene The western and eastern groups are thought to have been isolated geographically, forcing the western group to live on "forest pasturage" in the winter while the eastern group grazed on "dry grass of the

tundra steppe", thus influencing their morphological development (e g. dental characters and structure of the cranial and postcranial skeleton). It must be noted that along with morphological variations, these regional environmental differences need to be proven in order for the ecotype theory to be validated. Therefore, Late Pleistocene vegetation maps of north-west Europe are investigated further in chapter 3 in order to detect environmental variation, both geographically and chronologically.

Like Lundholm, G. Nobis (1971) has tackled the taxonomy of Holocene wild horses based on morphology, and in this paper he discusses both the tarpan and the Przewalski's horse and their status as wild 'types'. Nobis (1971) accepts that the central and southern European wild horse (the tarpan) and the Mongolian wild horse (i.e. the Przewalski's horse) belonged to the same *Equus ferus* group in the early Mesolithic, and since that time they have developed into distinct subspecies isolated both geographically and physiologically. He segregates *E. ferus* into two subspecies: 1) *Equus ferus gmelini* Antonius,1912 = the tarpan of south and central Russia and 2) *Equus ferus przewalskii* Poliakov,1881 = the Przewalski's horse of Mongolia. In addition, Nobis (1971) describes *Equus ferus ferus* as the Late Pleistocene eastern European wild horse contemporaneous with the central/western European wild horse, *Equus ferus solutreensis* from Solutré. However, Groves (1991) disagrees with Nobis' use of *Equus ferus ferus* for the horse remains from Mezin, Russia as the predecessor of *Equus ferus gmelini*, due to the erroneous naming of taxa using junior synonyms and the designation of "spurious type localities like Mezin without certifying that those remains were part of the same paradigm as the recent tarpan". The present author agrees that Nobis' use of '*gmelini*' and '*ferus*' for separate subspecies is confusing and proposes that only '*ferus*' should be used in reference to Boddaert's steppe tarpan of eastern Europe (above). In addition, the author is adamant that neither should be used as a subspecies name when describing Late Pleistocene taxa

As alluded to above, Nobis (1971, 1974) goes further by including a third subspecies of *E. ferus* into his postulated wild horse stock (see table 2.1). In the latest Pleistocene/Upper Palaeolithic material, he notices changes in size of the *E. ferus* group, some becoming small and sturdy, while others increase in size supposedly due to favourable conditions. Nobis (1974) deems the larger-sized horses as the tarpan and Przewalski's horses (the eastern variants of *E. ferus*), and the smaller ones, a form of the western subspecies, again *E. ferus solutreensis* (i.e a dwarf form of the earlier Solutré horse). Thus, Nobis (1974) considers *E. ferus* to be the wild foundation stock

of domestic horses which could be separated into three subspecies ranging in Eurasia to the north of the large mountain ranges during the Upper Palaeolithic: 1) *E. ferus gmelini*- the tarpan of south and central Russia; 2) *E. ferus przewalskii*- the Przewalski's horse of Mongolia; and 3) a pygmy form of *E. ferus solutreensis* in central and western Europe.

Uerpmann's (1990) more recent work asserts that due to the "plasticity" of Pleistocene wild horses, the transition from Pleistocene to Holocene, with its severe changes in climate, played its part in the evolution of the horse. That the species was genetically continuous did not stop it from developing geographical variation in form, those changes justifying new terminology for Holocene populations on the level of subspecies. Uerpmann (1990) makes it clear that none of the Pleistocene taxa should be used for Holocene wild horses unless "continuity of form can be explicitly proven even beyond the transition from the Pleistocene to the Holocene". In his paper concerning the history of the domestic horse, Uerpmann (1990) provisionally assumes that three or four regional forms of wild horse must have been present during the early Holocene. These forms are as follows: 1) a small Iberian wild horse which he calls *E. ferus lusitanicus* Uerpmann,1990 whose type material comes from Cueva de la Carigüela and Piñar, Spain; 2) a possible form from south-eastern Europe/Asia Minor which may have been as large or larger than the east European form which he calls *E. ferus scythicus* Radulescu and Samson,1962 whose type material comes from La Adam Cave, Romania; 3) a larger form in the continental steppes of eastern Europe which probably had a connection to similar populations in Central Asia which he calls *E. ferus ferus* Boddaert,1785; and 4) a medium-sized form in western Europe, ranging between the Pyrenees and the Baltic Sea which he calls *E. ferus sylvestris* v. Brincken,1828. The latter two subspecies nomenclaturally correspond to the steppe and forest tarpans, respectively; however, Uerpmann (1990) uses these terms to designate morphologically distinct regional forms in eastern Europe (e g. material from a Neolithic site in the Ukraine) and western Europe (e g. material from Neolithic sites in southern Germany and France). This is a dangerous practice because both these taxa (i e. '*ferus*' and '*sylvestris*') were based on recent (i e 17th/18th century) supposedly wild animals and not actual palaeontological material dated to the early Holocene. However, in recognition of these apparent problems, Uerpmann (1990) does warn that "this terminology does not rest on a thorough taxonomical revision of Holocene wild horses and is merely serving as a means of understanding the four regional forms on

which this article is based". Furthermore, because Uerpmann (1990) does not deal with Holocene British horses in depth, it is the aim of the current study to morphologically compare the above forms with the form(s) which were present in both the Late Glacial and early Holocene of the British Isles in order to see how they compare with his provisional scheme. These issues will be dealt with more fully in chapters 5 and 6.

The domestic 'types'

Various authors writing on the origins of domestic horses work from the domestic horses themselves, grouping them according to size, conformation, coat type and colour. Nobis (1974) notes that at the beginning of this century, domestic horses were separated into 3 distinct groups, each supposedly having one wild ancestor. The 3 groups described were: 1) Steppe horses- "warm-blooded" types descended from the Przewalski's horse; 2) Forest horses- identical to the "cold-blooded" group originating from the wild horse of Solutré (a member of western European fauna during the Pleistocene); and 3) Plateau or desert horses- reconstructed from English fossil remains of wild horses and whose founder was the so-called Celtic pony, *Equus caballus celticus* Ewart,1904 (a type which will be defined later). These groups recur several times in the literature, every time being defined differently. Epstein (1971) cites Duerst, Ewart, and Antonius as having classed wild horses of Europe and Asia into the same three groups mentioned above; however, he notes that each author uses the terms 'steppe', 'forest', and 'plateau' differently to describe a different wild 'type'. Willoughby (1974) illustrates an example of the confusion that has arisen: "Duerst's 'forest' type has as its representative another previously described type named *E. c. nehringi* Duerst,1908, from which, according to Duerst, has descended the Celtic pony (Ewart's 'plateau' type!)". This problem occurs repeatedly and it reflects the difficulty of separating the domestics from their supposed wild ancestors, both osteologically and nomenclaturally.

J. C. Ewart, the esteemed Regius Professor of Natural History at the University of Edinburgh in the early 20th century, was one of the most famous scientists to influence the taxonomy of the horse through both his breeding experiments and his studies of wild and domestic horses. Ewart (1904) was the first hippologist to coin the term 'Celtic pony', regarding it as a variety "which at a very remote period branched off from the main stem and possibly reached Europe and North Africa long before the advent of the Neoliths to become the progenitors not only of the occidental, but also

African races". He considered this extant type to be an "almost pure representative of once widely distributed wild species" based on its wild type colouring (i.e. like Przewalski's horse), its tail-lock adaptation, and its occurrence in isolated areas (e.g. Iceland, Faroe Islands, Shetland, Hebrides, western Ireland and Finland). According to Ewart (1904), *E. c. celticus* is a uniquely specialised horse able to deal with snow and specifically adapted to a subarctic environment. Also, in his 1904 paper, Ewart introduces another extant type called *E. c. typicus* Ewart (the Norse horse) which he considers to be a forest variety specially adapted morphologically for living in or near forests.

Ewart not only tackled the types which he believed to be extant, but it is evident that he (Ewart, 1904) took notice of differences in the morphology of Pleistocene horses from north-west Europe (e.g. horses of Solutré, France and Kent's Cavern, England). Dealing with them in more depth in a subsequent paper, Ewart (1909-10) established three ancestral forms: 1) a Steppe type which is represented by *E. przewalskii*; 2) a Plateau type he calls *E. agilis* Ewart, supposedly the ancestor of ponies of the Celtic type (i.e. *E. c. celticus*) ; and 3) a Forest type he calls *E. robustus* Pomel,1853. Ewart (1909-10) defined his species *Equus agilis* more clearly as being a "fine-limbed" (i.e. slender-limbed) horse having "small-pillared" molars (i.e. with small protocones) and ranging during the Pleistocene from Algiers to England (e.g. Kent's Cavern). For this slender-limbed horse he distinguished two varieties as having existed during the Pleistocene: 1) a northern variety (*Equus agilis celticus* Ewart) with a coat, mane, and tail adapted to cold, damp climates which also is thought to be the part ancestor of the modern ponies of the Celtic type (e.g. Shetland pony); and 2) a southern or North African variety (*Equus agilis libycus* Ewart) with a fine coat, thin mane and tail without a tail-lock which also is thought to have contributed largely to the making of the finer Barbs and Arabs. His Forest type, on the other hand, is represented by what he called the "stout horse of Solutré", a type similar to, but smaller than the heavily built horses from the "Pleistocene beds of Essex" (Ewart, 1904, 1909-10). Even though Ewart attempted to identify these wild ancestral types in Pleistocene material, he is not beyond criticism. In particular, his nomenclature is confusing and incorrect. For example, while using '*celticus*' for both wild and extant domestic subspecies where one is supposedly ancestral to the other, nowhere does Ewart describe or define a nominate subspecies '*Equus celticus celticus*'. Moreover, as indicated by Mayr (1963), the subspecies is "not a unit of evolution". Furthermore,

Willoughby (1974) rightly criticises Ewart's lack of a complete morphological comparison of supposed ancestral and living forms which is necessary in order to "demonstrate the contribution of wild forms to the ancestry of the domestics".

Hilzheimer (1935) also distinguishes two or three types of wild horse as having existed during the Palaeolithic of western Europe. His two definite types are the Przewalski's horse (*Equus przewalskii* Poliakov) and the tarpan (*Equus gmelini* Antonius). He cites Ewart's *Equus celticus* as another 'breed' for western Europe which is based on the "divergent" types of pony in northern Britain and Norway. Also, Hilzheimer (1935) separates the domestic horses into two groups based on geography, distinguishing between oriental and occidental breeds It is evident from the above that problems arise when some authors surveying the origins of domestic horses muddle their groupings. For example, both Ewart (above) and Hilzheimer have difficulty separating the idea of ancestral wild types from the idea of domestic breeds which conform to a 'type' represented by a hypothetical wild ancestor. This causes much confusion because the evidence (i.e. fossil/sub-fossil material) tends to be disregarded as peripheral to the origins 'story'.

Both Epstein (1971) and Groves (1991) cite Skorkowski (1956, 1961) who insists that the various 'racial' types found amongst the recent domestic horse populations already existed during the Magdalenian of the Upper Palaeolithic. Epstein (1971) provides an overview of Skorkowski's proposed classification which divides domestic horses into six cranial types, and according to Epstein (1971), each represents "wild subspecies identifiable with fossil horses from which a number of domestic breeds are derived in different mixtures" Skorkowski's nomenclature is based on the hypothesis that every suggested subspecies of *Equus* of the Pleistocene period has survived to the present day (Epstein, 1971). For each group, he gives a subspecific name of the species *caballus*, the size of the horse type, its cranial profile, its typical coat colour and modern representatives or prototypes. The six groups are: 1) *E. c. mosbachensis* von Reichenau- a large heavy horse; 2) *E. c. abeli* Antonius,1913- a heavy massive horse; 3) *E. c. muniensis* ("Ewart's steppe variety")- a light horse; 4) *E. c. ewarti* ("Ewart's Siwalik type")- a light horse; 5) *E. c. cracoviensis* ("Ewart's plateau type")- a small pony, and 6) *E. c. nordicus* ("Ewart's Norse horse")- a small horse Several authors have criticised Skorkowski's groupings as being "a neglect of fundamental biological knowledge" (Herre, 1961; Epstein, 1971); and Meunier (1962)

believes that these postulated types are not subspecies but "individual variations that occur in different polytypic subspecies".

Groves (1991) notes that only some (e.g. '*abeli*', '*mosbachensis*') of Skorkowski's types are based on actual fossil material. However, it must be stated that the 'true' '*E. mosbachensis*' dates, at the latest, to the early Middle Pleistocene (i.e. c. 500,000 BP). Also, some of Skorkowski's other types (e.g. '*ewarti*', '*nordicus*') are considered by Groves (1991) to be "constructs from beginning to end" (Groves, 1991). Indeed, even Ewart does not call the Siwalik and Norse horses by these names, but rather *E. sivalensis* Falconer and Cautley (an Indian stenonid horse) and *E. c. typicus*, respectively.

In some of the works written on the origins of domestic horses, many of the postulated theories are combined at once. For example, in his popular text about the horse, Edwards (1987) first categorises *E. caballus* into three defined "primitive" types from which domestic horses could be descended. The first type is the Asian steppe horse represented by the Asiatic wild horse ("*E. przewalskii przewalskii* Poliakov"). The second type is the more western plateau horse represented by the tarpan of forest and steppe varieties ("*E. przewalskii gmelini* Antonius") which inhabited areas of eastern Europe and the Ukrainian steppes. The third "primitive" type, now thought to be extinct, is the forest or diluvial horse ("*E. przewalskii silvaticus* Vetulani") which was a heavy, slow moving horse living in wet, marsh-type lands of northern Europe. Edwards (1987) also provides evidence for a fourth type of wild horse considered by some to be a 'tundra' horse of white coat colour and living in the far north of Eurasia (e.g. north-east Siberia). This suggestion probably has its origins in Antonius' (1937) hypothesis for a particular wild species which was supposedly a relict of a northern branch more widely distributed in the past, including eastern Siberia and possibly Alaska. He did not give this species a name, but described it as a "local race of true wild horse" which was known to have been white in colour and to have been found in excavations which uncovered the Beresovka mammoth in 1901 (Antonius, 1937). It is now known that this wild horse is really the ubiquitous steppe-tundra animal of the Late Pleistocene of Eurasia.

To complicate matters further, Edwards (1987) also relates a "most favoured and publicised theory" concerning domestic horse ancestry which had been developed jointly by J. G. Speed of Edinburgh, E. Skorkowski of Cracow, and F. Ebhardt of Stuttgart. These scientists analysed the bone structure, teeth and behaviour of many

types of horses (both wild and domestic, extant and fossil) and came up with a further four hypothetical wild subspecies which existed during the Holocene in Eurasia, supposedly derived from the "primitive" horses mentioned above: 1) Pony Type 1- thought to stand at about 12-12.2 hands high, have a broad forehead, straight profile and small ears similar to the present day Exmoor pony; 2) Pony Type 2- thought to be heavily built, coarse, and heavy-headed with a convex profile and standing 14-14.2 hands high, inhabiting northern Eurasia and being similar to today's Highland pony; 3) Horse Type 3- thought to be taller at about 14.3 hands high with a long narrow body, a long neck and long ears, inhabiting Central Asia and similar to today's Akhal-Teke of Turkmenistan; and 4) Horse Type 4- thought to be an Arab prototype smaller than the others, but with "greater refinement", a concave profile and high-set tail living in Western Asia and similar to the Caspian Pony of Iran (Edwards, 1987). Thus, "primitive" wild types as well as hypothetical domestic horse ancestors are introduced without any mention of type specimens or type localities. This illustrates the sketchy and weak scientific evidence employed by authors of many modern popular horse texts to explain domestic horse origins. For example, in a recent review of the Przewalski's horse in Mongolia, Kolbas (1997) reproduces Edwards' (1987, 1993) four "primitive" types (i.e. Przewalski's, tarpan, forest and tundra) without discussion of the validity of each. As stated above, one of the aims of the current study is to provide reliable evidence for the ancestors of domestic horses while clearing up the confusion surrounding the hypothetical ancestors.

So far, this review has dealt mainly with the morphological attributes of hypothetical forms or types. However, both Forsten (1988) and Nobis (1974) note that Ebhardt's (1958) proposals are based on behavioural as well as morphological attributes of domestic horses. He groups domestic breeds according to their behavioural and conformational variability, with the implication that this same variability was present in their wild ancestors. Forsten (1988) rightly criticises this assumption that prehistoric and domestic horses had "set behaviour patterns". The examples given in chapter 1 demonstrate that horses (both wild and domestic) show extreme flexibility in their behaviour under various environmental and climatic conditions, thus exhibiting no strict pattern. Again, this illustrates the dangerous practice of working 'backwards' from modern domestic horses in order to propose ancestral 'types'.

2.4.3 Native ponies and their origins

A subject that has perplexed many authors investigating the origins of domestic horses has been that of the position of Europe's native ponies. Some of these breeds are thought to have a long history going back hundreds of years or more. Ewart (1909-10) considers the ponies of north-west Europe to be "mainly a blend of the coarse-limbed, broad-boned, short-faced race of the Solutré-type and the finer-limbed race characterised by a fine muzzle and short pillared molars". Furthermore, Beck (1992) describes north European native ponies as being very ancient and resembling what we know of wild horses. Thus, the questions that need answering concerning native breeds are "Where do native ponies fit into the scheme of domestic origins?", "Exactly how primitive are these native breeds?", and "If they are primitive types, what are their relationships to primitive wild types such as the Przewalski's horse and the tarpan?".

One native breed of pony which has caused much controversy and emotional debate is the Exmoor pony of Great Britain, a mountain and moorland breed (sometimes known as a British Hill Pony). The first written reference to ponies on Exmoor was given in the Domesday Book in 1086 AD and it can only be assumed that these were free-living ponies of the Exmoor type; however, it was not until literature of the late 18th century that Baker (1993) could find a secure record which distinguished the native Exmoor ponies from other horses. Today's Exmoor pony is a hardy animal able to withstand the rugged environmental and climatic conditions on Exmoor and other upland areas (e g. Tarn House, Cumbria). Both Gates (1981) and Baker (1993) distinguish the free-living Exmoor pony from other domestic, feral and wild equids based on behavioural, morphological, and external attributes According to them, the Exmoor should be termed 'econatural' which applies to animals which while partly managed by humans, still retain their original genetic identity and natural ecology. Also, if the 'ecotype' concept is accepted (see above), the Exmoor pony could be considered an appropriate example.

Many authors have made it their life's work to investigate and prove the 'primitiveness' of various native pony breeds. J. C. Ewart, J. G. Speed and M. G Etherington, and Sue Baker have spent many years investigating native ponies, especially the Exmoor pony and its origins. Ewart (1904, 1909-10) considered the Exmoor to be, in its morphology, a "nearly equal blend of 'forest' (*E. robustus*) and 'plateau' (*E. agilis*) types". Also, Speed and Etherington (1952) contend that the evolution of some modern horses may have occurred in or near Britain, and that it is

possible the Exmoor pony was a product of this evolution. Their research into the origins of the horses of the British Isles led them to an investigation of fossil material from British Pleistocene sites. However, they seemed to concentrate on only a small amount of fossil material from the Mendip region instead of completing a thorough survey of a range of material from British sites as has been accomplished in the current study (see chapter 4). Based on their investigation of the Mendip horse material, Speed and Etherington (1952) concluded that there were two types of original native ponies in Britain. They described the first as a smaller "Exmoor" or mountain/hill pony type which they found to be present in both earlier and later strata of Pleistocene deposits. The second was described as a larger or "pack-horse" type, which Baker (1993) subsequently describes as a "steppe type" horse, thought to be present only in the later strata. It is Baker's (1993) suggestion that only the smaller "Hill Pony" survived the transition from Late Glacial into Post Glacial on the moorland and upland areas of Britain and therefore is the ancestor of today's Exmoor ponies. However, it must be stressed again that the main aim of the present study is to assess a wider range of evidence than above in order to make more secure conclusions regarding British horses.

Ewart (1904) contends that the extant "dark brown variety of the Celtic pony may represent an old variety" from which the Exmoors were descended. In order to gain an even better understanding of Exmoor origins, Speed and Etherington made comparisons with present day native ponies. In further studies, Speed and Etherington (1953, 1977) attempted to clarify the Celtic pony of Ewart more precisely by describing it as a common domestic animal of Bronze Age and Iron Age settlers, being originally derived from the indigenous small 'Exmoor pony type'; however, they do make it clear that the Celtic ponies themselves are neither native nor 'endemic'. Because the views of both Ewart and the Speeds (as they are better known) seem discordant, it is difficult to assess the true status of the Exmoor based on their work. The present author is inclined to regard the work of the Speeds as more praiseworthy simply because they devoted much time and effort to studying the Exmoor pony as well as British fossil horse material, even if their conclusions are somewhat misguided. Sadly, however, they are no longer alive and their study of the origins of the British horses remains unfinished and incomplete. By contrast, it seems that Ewart (e g. 1909-10) was only speculating about the relationships of domestic breeds and their supposed wild ancestral forms based on his crossing (i.e breeding) experiments, which

according to him, produced different forms (e.g. a robust "forest" type), rather than basing his theories on actual morphological differences of wild and early domestic forms.

Some authors disagree with the popular idea that the Exmoor is a primitive horse which has survived the Pleistocene-Holocene transition and is closely related to the prehistoric wild horses which roamed Britain through the Pleistocene. Mohr (1971) claims that due to the extensive mixing and dilution of their wild ancestors' blood by imported breeds since early times, they can in no way be regarded as pure descendants. Many authors subscribe to a similar view that the Exmoor, along with other European native ponies, could not possibly be the close living relatives of extinct wild horse types which had been widely distributed in prehistoric times. Groves (1991) is of the opinion that because no wild horses supposedly survived far enough into the British Holocene to be considered close relatives of the Exmoor, this pony breed, although hardy in nature, is a feral race. However, because Groves' (1991) view does not sufficiently explain the apparent primitiveness of native ponies such as the Exmoor, it becomes necessary to expand the database of information regarding extant horses as well as their wild ancestors in Eurasia. Some of the key points which need to be addressed relate to taxonomic, chronological, distributional, environmental and morphological issues. The present study of the horse fossil record in Britain aims to provide some much-needed new evidence in these areas, much of which will be dealt with in the following chapters (chapters 4 and 5). Once this information has been collated and thoroughly analysed, firm conclusions can be drawn regarding the origins of domestic horses (including native pony breeds) Additionally, this study aims to combine the widest variety of investigations (e.g. morphological with molecular; chronological with environmental) in order to present a complete profile of ancient and modern British horses. For a further discussion of how effective this combination has been see chapter 6.

Chapter Three Stratigraphy, Environments, Faunas and Archaeology

3.1 Introduction

The aim of this chapter is to introduce and define many of the terms and ideas which will be employed throughout this thesis in relation to stratigraphy, climate, environment, faunas and archaeology. Because the Late Glacial and Post Glacial intervals are central to the current work, they will be dealt with in more depth than the other intervals of the Devensian or Weichselian. However, in order to focus in on the Late Glacial, it will also be necessary briefly to introduce the preceding stages (Middle Devensian/Weichselian) of the last glacial episode.

Three key themes regarding the latest Pleistocene and Holocene of Britain and continental (especially north-west) Europe will be highlighted below using a variety of tables (3.1-3.7) and one key figure (3.1) (also see table 3.8 at the end of this chapter for relevant references):

- Stratigraphic Terminology or "Nomenclature"
- Climate and Environment
- Characteristic Mammal Faunas

3.2 Latest Pleistocene and Holocene terminology (including archaeological terminology)

Because this work incorporates three different, though closely situated, geographical areas of Europe (i.e. Britain, Ireland and continental Europe), it is necessary to introduce three separate sets of stratigraphical nomenclature for the Last Glacial/Interglacial transition (LGIT) (table 3.1). Within the Last Glacial interval (Devensian, Weichselian, or Midlandian), was the so-called 'Late Glacial' which consisted of "short-lived warming and cooling episodes" (i.e. interstadials and stadials, respectively) (Barton *et al.*, 1991). The key subdivisions in Britain include the Windermere Interstadial and the Loch Lomond Stadial, while those from north-west

Table 3 1. Stratigraphical Nomenclature for the Late Pleistocene/Holocene Correlations between Britain, Ireland and Continental Europe

	Britain	Ireland	Continental North-west Europe
Holocene (or Present Interglacial)	Flandrian Interglacial	Littletonian Interglacial	Flandrian Interglacial
Subdivisions of the Late Glacial (c. 13,000 to 10,000 BP)	Loch Lomond Stadial	Nahanagan Stadial	Younger Dryas Stadial
	Windermere Interstadial	Woodgrange Interstadial	Allerød Interstadial
			Older Dryas Stadial
			Bølling Interstadial
Late Pleistocene (or Last Glaciation)	Devensian Glaciation	Midlandian Glaciation	Weichselian Glaciation

Europe consisted of the Bølling and Allerød Interstadials and the Older and Younger Dryas Stadials (table 3.1) (e.g. Barton *et al.*, 1991; Lowe and Walker, 1997; Woodman *et al.*, 1997). Furthermore, the present temperate 'interglacial' (i.e. the Holocene) of both Britain and parts of continental north-west Europe is termed the Flandrian: a British chronostratigraphic term whose name "derives from the marine transgression which culminated during the present warm stage on the Flemish coastal plain" (Lowe and Walker, 1997). All radiocarbon dates quoted in the following text (and tables) as well as subsequent chapters are given in uncalibrated radiocarbon years before the present (BP), where the 'present' is set at AD 1950. All radiocarbon ages are based on the Libby half-life for radiocarbon (^{14}C) of 5,570 years (Barton *et al.*, 1991).

The subdivisions of the Last Glacial/Interglacial transition (LGIT) are given in table 3.2 and consist of several different correlated schemes. These schemes are employed throughout the current work, sometimes singly or in conjunction with one another, and they consist of absolute chronology (i.e. radiocarbon years), biostratigraphic units (i.e. biozones or characteristic vegetational/faunal assemblages: e.g. pollen zones as defined by Iversen, 1954), chronostratigraphic units (i.e. chronozones based on Mangerud *et al.*, 1974), and archaeological periods (Megaw and Simpson, 1984; Cunliffe, 1993). Although table 3.2 shows boundaries between the zones within a scheme, these should not be considered as rigid Instead, it is necessary to think of each 'boundary line' as highlighting the transition into the next zone rather than as a separator. Lowe and Walker (1997) stress this idea with regard to biozones in that "because of the time-transgressive nature of climatic and environmental change,

Table 3.2. British and European Subdivisions of the Last Glacial/Interglacial Transition (including the Mid-Late Devensian, Late Glacial, and Post Glacial)

	^{14}C years BP (approximate only)	Pollen Zones	Pollen Zone Names	Chronostratigraphic Units	British Archaeology	
POSTGLACIAL	Present-Day				Modern Medieval Norman Anglo-Saxon Romano-British Iron Age	
	2,500	VIII	Sub-Atlantic			
					Bronze Age	
	5,000	VIIb	Sub-Boreal		Neolithic	
				Flandrian	Neolithic	
	7,500	VIIa	Atlantic	Interglacial	Mesolithic	
	9,000	VI	Later Boreal		Mesolithic	
	9,600	V	Early Boreal			
					Mesolithic	
	10,300-10,000	IV	Pre-Boreal		Late Upper Palaeolithic (LUP)	
LATEGLACIAL				Loch Lomond Stadial		CRESWELLIAN
	11,000	III	Younger Dryas Stadial			
	11,800	II	Allerød Interstadial			
				Windermere	Late Upper	
	12,000	Ic	Older Dryas Stadial			
				Interstadial	Palaeolithic	
					(LUP)	
	13,000	Ia & Ib	Bølling Interstadial			
PRE-LATEGLACIAL	15,000		Pre-Bølling (or 'Oldest Dryas')	Dimlington Stadial		
					Early Upper Palaeolithic	
	25,000				(EUP)	
				Middle Devensian		

Table 3.3. Continental Archaeology for the Mid-Late Weichselian (including the Late Glacial and Early Post Glacial)

yrs BP	GERMANY	FRANCE	
9,000			
10,000	MESOLITHIC	AZILIAN	
11,000	AHRENSBURGIAN	MAGDALENIAN	VI
13,000	FEDERMESSER		V
			IV
			III
			II
			I
20,000		SOLUTREAN	
35,000		PERIGORDIAN (or Gravettian) AURIGNACIAN	

the boundaries of biozones (e g. pollen assemblage zones, molluscan assemblage zones, diatom assemblage zones) cut across time horizons and frequently transgress the boundaries of other stratigraphic units".

Furthermore, it is necessary to stress that the archaeological subdivisions shown in table 3.2 relate strictly to Britain, whereas table 3.3 displays some of the relevant archaeological terms which are applied to continental study areas significant to the current project (i.e. Mid-Late Weichselian of Germany and France) (see chapter 4, section 4 4)

3.3 Review of the climatic and environmental changes during the latest Pleistocene and Holocene

Distinct, sometimes severe, climatic and environmental (e g vegetational) changes are known to have taken place throughout the Late Glacial to Flandrian interval For the purposes of the current work, it is necessary to separate this long interval into two periods the Late Glacial/early Post Glacial (c. 15,000-9,000 BP) and

the Post Glacial (c. 9,000 BP onwards). The earlier period incorporates the pre-Bølling (i.e. pre- c. 13,000 and including the 'Oldest Dryas') which according to Lowe and Walker (1997) should be considered when discussing the pattern of environmental change for LGIT. Table 3.4 shows the vegetational and climatic succession which took place in Britain and continental European areas from pre-Late Glacial times through to the latest Post Glacial. Data on climatic and vegetational change incorporated in this review are based on pollen, plant macrofossils, fossil Coleoptera and Mollusca, isotopic evidence, and geological evidence (e.g. landforms, sediments) (Walker *et al.*, 1994; Lowe and Walker, 1997). Lowe and Walker (1997) recognise four, "informal and loosely dated", "distinct climatic episodes" (see table 3.4) for this important interval in north-west Europe: 1) an initial cold phase prior to 13,000 BP in which the first signs of warming are evident (= Oldest Dryas); 2) a period of significantly warmer conditions from c. 13,000-11,000 BP (= Late Glacial Interstadial); 3) a second cold episode from c. 11,000-10,000 BP (= Younger Dryas or Late Dryas Stadial); and 4) a phase of climatic amelioration from c. 10,000 BP onwards (= early Flandrian Interglacial).

3.3.1 Climate and environment during the Late Glacial/Post Glacial: Britain

The Late Glacial in Britain began with the Windermere Interstadial (c. 13,000-11,000 BP), a period in which the climate was ameliorating from the cold conditions of the Dimlington stadial which had previously supported an open-habitat herbaceous flora as well as an arctic coleopteran fauna (Lowe and Walker, 1997; Coope, 1977) (see tables 3.2 and 3.4). The transition to warm interstadial conditions was rapid at c. 13,000 BP, and a thermal maximum (16-18 °C mean July temperature) was reached between c. 13,000-12,500 BP for the British Isles. The vegetation during the early part of the Windermere Interstadial (i e. early Bølling) was dominated by grasses (Gramineae), sedges (Cyperaceae) and herbaceous plants (e.g. docks, *Rumex*; wormwoods, *Artemisia*) which thrived on open ground and disturbed soils. This community was slowly succeeded by open wood and scrub environments made up of shrubs such as juniper (*Juniperus*) and willow (*Salix*). Also, although open woodland (birch, *Betula* and pine, *Pinus*) was known to have developed in areas of central and southern Britain, areas in north-east England and eastern Scotland did not support such developed woodland as a result of exposure to the inhospitable conditions of the "North Sea plain". This evidence suggests that early in the Late Glacial, there was

Britain's Vegetation	Climate	yrs BP
	warmer	1,000
	cooling	2 000
Open Woodland	warmer	2,500
(extensive forest clearance)		
Woodland with Open Areas	cooling	4,000
Elm decline	warm, dry, continental	5,000
Mixed Deciduous Woodland	warm, wet, oceanic	7,500
Woodland	warm, dry	9,000
Woodland (some open)	warming	9,500
Transition to Woodland	warming	10,000
		10 500
Tundra and Low Alpine Scrub	arctic	11,000
Birch Woodland	(?milder)	11,500
Birch Woodland (extensive in south/sporadic in north)		12,000
Open Wood and Scrub	cooling	12 500
Open Ground Communities	warm	13 000
Open Tundra and/or Steppe	arctic	pre-14 000

Table 3.4. Vegetation and Climate: Britain versus Continental Europe

climate based on fossil coleopteran records and palaeobotanical data; **vegetation** based on pollen-analytical evidence and plant macrofossil data (after Walker *et al.*, 1994 and Lowe and Walker, 1997)

* These four units have also been regarded as "climatostratigraphic" episodes (Lowe and Walker, 1997)

Chronostratigraphic Units*	North-west Europe's Vegetation	Climate
	Woodland (some Boreal Forest)	warming
Flandrian Interglacial	Transition to Woodland (some closed)	warming
	Open Woodland and Park Tundra	cold, arid
Younger Dryas Stadial	Transition to Boreal Wood and Heathland	cold
	Transition to Woodland	warm
Late Glacial Interstadial	Open Scrubland and Herbaceous Communities	cold
	Open Woods	warm
	Transition to Wood and/or Scrub	warming
Pre-Bølling (or 'Oldest Dryas')	Open Tundra and/or Steppe	arctic

already some regional differentiation in vegetation patterns probably as a result of "variations in plant response to climatic change at different latitudes and altitudes" (Lowe and Walker, 1984).

From c. 12,500 BP onwards, a deterioration in the climate took place through to the Loch Lomond Stadial (or Younger Dryas) which began at c. 11,000 BP, but with distinct climatic oscillations between c. 12,000-11,000 BP (i.e. the Allerød) (fig. 3.1 and table 3.4). During this period, much of southern Britain supported a woodland environment which consisted of *Betula* and poplar (*Populus*) (Cunliffe, 1993), while woodland presence was "sporadic" in the north of the country (Walker *et al.*, 1994). It is still not clear whether the 'Earlier' or 'Older Dryas' oscillation at c. 12,300-11,800 BP was a significant climatic and environmental event in the British Isles. Preece and Bridgland (1998), however, have detected evidence (e.g. beetles) of a short-lived cooling event at the Late Glacial site of Holywell Coombe, south-east England. This compares well with the continental description of the 'Older Dryas' which is thought to have been marked by a decline in temperatures as well as trees and shrubs, and an increase in open-habitat herbaceous taxa (e.g. *Artemisia, Rumex*). Another significant oscillation event (a brief period of warming and recovery of *Betula* woodland in lowland Britain) is known to have occurred at c. 11,400-11,300 BP, equivalent to the later Allerød (Walker and Harkness, 1990; Walker *et al.*, 1994). However, these oscillations can possibly be interpreted as local events which may not have occurred throughout all latitudes and altitudes (Lowe *et al.*, 1994).

During the Younger Dryas interval c. 11,000-10,000 BP, the climate deteriorated to a low of -20 °C (mean January temperature) and 8-10 °C (mean July temperature) with a glacial maximum at c.10,800 BP (fig. 3.1). The environment reverted to a landscape dominated by Gramineae, Cyperaceae and other herbaceous taxa associated with tundra and low-alpine scrub which replaced the woodland and heathland assemblages of the previous interstadial (see table 3.4) (Walker *et al.*, 1994; Lowe and Walker, 1997). Amelioration of the climate during the later Younger Dryas developed from c. 10,500 BP, and between c. 10,500-10,000 BP the climatic and environmental conditions supported a more arid assemblage with an increase in steppe and halophytic vegetation (e g. *Artemisia* species) (Lowe and Walker, 1997). Stadial conditions are thought to have ended c 10,300-10,000 BP, at which point another abrupt climatic amelioration took place (fig. 3 1); and by c. 9,800-9,500 BP, reconstructed temperatures based on Coleopteran and pollen evidence were comparable with those of

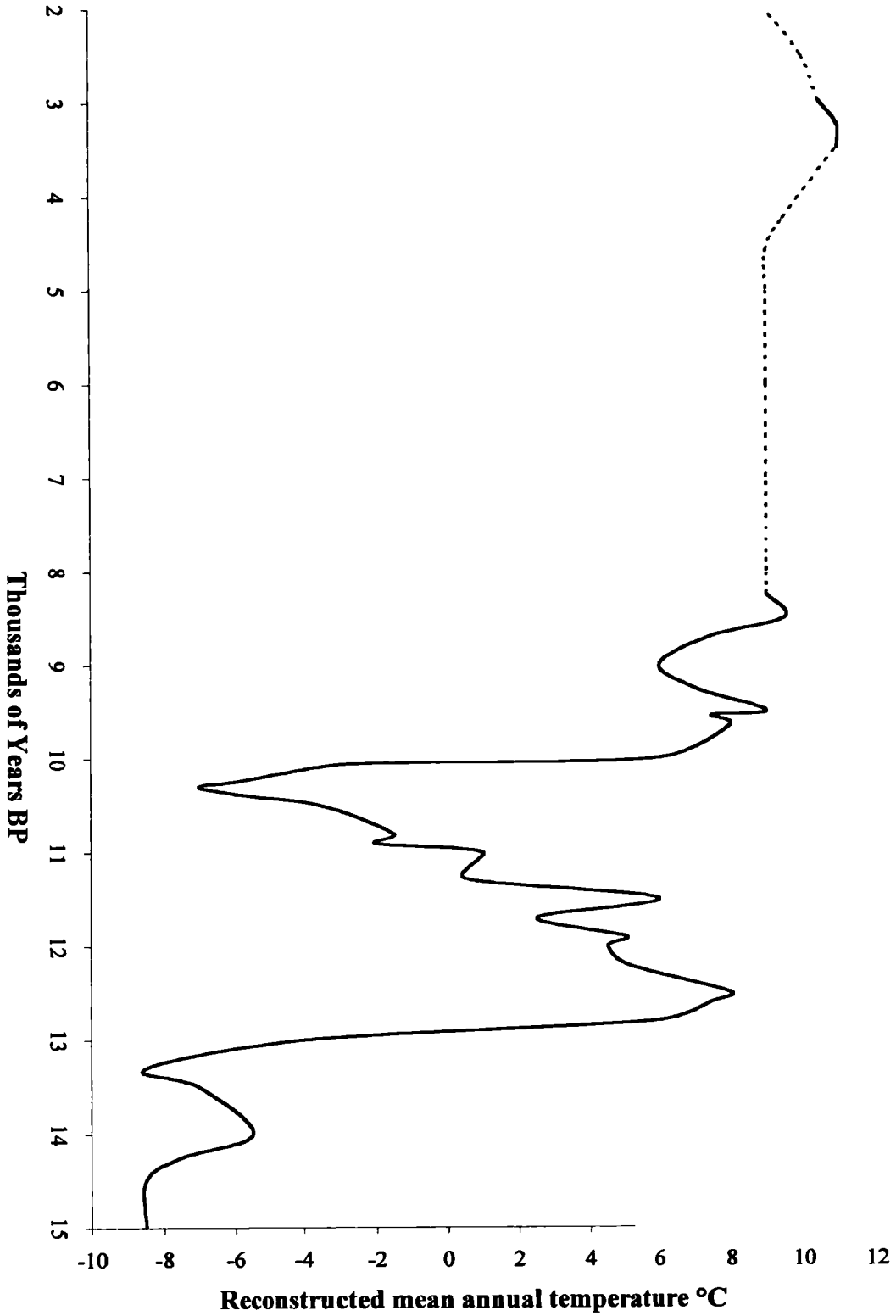

Fig. 3.1. Temperature curve for Britain (based on radiocarbon-dated beetle faunas): Late Glacial/Post Glacial. solid line = most probable value; dashed line = interpolated value. (redrawn from Stuart (1991), after Atkinson *et al.* (1987))

the earlier interstadial maximum as well as those of the present-day (Lowe and Walker, 1984; Atkinson *et al.*, 1987; Walker *et al.*, 1994). Walker *et al.* (1994) note that vegetational changes were also evident at the Late Glacial/Post Glacial transition period in which open ground and/or heathland communities (e g. Gramineae; crowberry, *Empetrum*) were succeeded by woodland (e.g. *Betula*; hazel, *Corylus*; *Pinus*) (see table 3.4). Climatic reconstructions based on beetle faunas (Atkinson *et al.*, 1987; Stuart, 1991) also provide evidence for short-lived oscillations during the early Post Glacial interval of c. 9,500-8,500 BP (fig. 3.1) which compare favourably with those detected in other areas of north-west Europe (e.g. Switzerland: c. 9,500 BP and western Norway: c 9,500-9,100 BP) (Lowe and Walker, 1997).

Even though afforestation and amelioration was established by c. 9,000-8,000 BP, there were still areas in Europe where open woodland with "herbaceous glades" existed (Adams, 1997). In Britain, the climate was warm and dry throughout much of the Boreal period (zones V and VI: c. 9,500-7,500 BP, tables 3.2 and 3.4), and the appearance in England of lime (*Tilia*), oak (*Quercus*) and elm (*Ulmus*) marked the climatic optimum which was reached during this period (i.e. a maximum mean annual temperature of c. 2 °C higher than today) (Megaw and Simpson, 1984). However, in the Atlantic (zone VIIa: c. 7,500-5,000 BP, tables 3.2 and 3.4) a wetter (i.e. oceanic) climate prevailed along with the development of mixed oak (i.e. deciduous) forest (e.g. *Tilia*; alder, *Almus*, *Ulmus*) (Cunliffe, 1993). Adams (1997) notes that ice core data support a cooling event at c. 7,400 BP for northern Britain; however, this event does not seem to show up in the climatic reconstruction based on radiocarbon dated beetle faunas (fig. 3.1) Later, the Sub-Boreal (zone VIIb: c. 5,000-2,500 BP) was characterised by the decline in *Ulmus* and the onset of a warm (fig 3.1; tables 3.2 and 3.4), somewhat drier continental climate as well as an increase in herbs, grasses, and cereals which followed the development of an open landscape, but with "recurring cycles of wetter weather" (Cunliffe, 1993). It must be noted that between c. 7,000-5,000 BP, the impact of humans and their agricultural practices (e g. burning and clearing of forests) on the environment were beginning to tell, and by c. 4,000-3,000 BP, most of Europe had been 'touched' by agriculture (i.e. larger-scale land clearances). Furthermore, although it is not apparent on figure 3.1, it is important to mention Adams' (1997) referral to a wet/cool phase at c. 4,000 BP (e.g. in north-west Scotland) (table 3.4). However, another phase of increased rainfall and declining temperatures at c 2,600 BP (in north-west and central Europe), also mentioned by

Adams (1997), correlates with that noted by Megaw and Simpson (1984) during the Sub-Atlantic (zone VIII: c. 2,500 BP onwards, tables 3.2 and 3.4); and it appears as part of a distinct climatic oscillation on figure 3.1. Because this period is also marked by a decline in woodland as a result of large-scale forest clearances by humans during the Iron Age, Megaw and Simpson (1984) deem it necessary to "consider the vegetational changes in terms of human interference" during this later Post Glacial period. Also, it must be noted that variation in climate and environment at different latitudes and altitudes was no doubt evident throughout the early and middle Post Glacial vegetational changes described here. For example, Cunliffe (1993) describes two very different environments within the same region (western Somerset, England [Region 9]: see table 4.1, chapter 4) during the Early Mesolithic (Pre-Boreal/Boreal) in which the "gravel flood valleys" were "choked with woodland", while the "uplands of Mendip and the Quantocks" consisted of "areas of open woodland and scrub providing rich grazing for large game such as deer".

Regarding connections to the Continent and Ireland, it is known that the severe changes in climate during the Late Glacial made an impression. Lowe and Walker's (1984) suggestion that a sea level of -60 m OD was reached around the British coasts "at some time during the Interstadial" means that Ireland became separated from mainland Britain at the advent of the Late Glacial amelioration. At the same time, England was still connected to the Continent via "land bridges across the eastern English Channel and the southern half of the North Sea". On the other hand, Woodman *et al.* (1997) suggest that during the Late Glacial, the routes into Ireland possibly consisted of "thin ice and intermittent or swampy land connections", and therefore, it is difficult to pinpoint the presence and subsequent absence of a single landbridge event. In addition, Megaw and Simpson (1984) note that a landbridge connecting Ireland to Scotland may have persisted into early Post Glacial times. By the Later Boreal (c. 9,000-7,500 BP), rising sea levels and inundation of the North Sea plain associated with the Post Glacial amelioration began to isolate mainland Britain from the Continent for good (Cunliffe, 1993), and a maximum transgression took place during the later Atlantic. Furthermore, according to Megaw and Simpson (1984), the high precipitation evident during the Atlantic interval (zone VIIa c. 7,500-5,000 BP, tables 3.2 and 3.4) suggests that there was full oceanic circulation around Britain

3 3.2 Climate and environment during the Late Glacial/Post Glacial: continental Europe (with specific reference to north-west Europe versus Britain)

According to Walker *et al.* (1994), prior to c. 13,000 BP "open tundra and/or steppe communities dominated by *Artemisia*, *Rumex* and Gramineae" existed in most areas of north-west Europe. At c. 13,000 BP, all areas of Europe experienced a rapid climatic amelioration. However, unlike the British Isles, Netherlands, south-west Europe and lowland Switzerland, other areas of continental north-west Europe did not attain the thermal maximum of the Late Glacial Interstadial until later in that interval, c. 12,500-12,000 BP (for southern Scandinavia and Germany) and c. 11,500-11,000 BP (for south-west and northern Norway) (Lowe and Walker, 1997) (table 3.4). More open ground communities persisted at various intervals (e.g. climatic downturn of the 'Older Dryas': c. 12,000 BP, table 3.4) during the earlier Late Glacial (c. 13,000-11,500 BP) in north Belgium, the Netherlands and north-west Germany as compared to parts of Britain where woodland development was more widespread, especially in the south (Walker *et al.*, 1994). After c. 11,500 BP, while Britain was experiencing climatic deterioration and transition to tundra and low-alpine scrub communities, the other areas of the Continent were developing a boreal woodland and heathland environment with some open woodland and park tundra communities (e.g. north-west Germany) (see table 3.4). During the Younger Dryas, all areas experienced cooler and more arid conditions (later Younger Dryas), but of varying amplitudes from west to east (i.e. decreasing in severity from Britain to Germany) (Walker *et al.*, 1994). The climatic amelioration at the transition from the Younger Dryas to the Holocene (c. 10,500-9,500 BP) was widespread throughout Europe where the steppe and/or park tundra vegetation of the Younger Dryas was gradually succeeded by woodland (e.g. *Betula-Pinus-Corylus* in north-west Europe and *Abies* (firs)/*Corylus-Quercus* woodland in southern Europe) (Lowe and Walker, 1997) (table 3.4).

In light of the climatic and environmental gradients which were evident throughout much of the Late Glacial, it is necessary to highlight the effect of Britain's geographical position in Europe on the extent of its climatic (and environmental) variability during this period. According to Lowe *et al.* (1994), during the LGIT (c. 14,000-9,000 BP), the British Isles were lying "adjacent to the sector of the Atlantic Ocean that experienced the greatest amplitude of climatic change". For example, Atkinson *et al.* (1987) note that the British climate was unique in that it was continuously changing from before 13,000 BP to some time after 9,800 BP, and that

temperatures (especially in winter) were inconsistent and unstable throughout this interval.

Because of the potential climatic and environmental variation within the Post Glacial of continental Europe, a complete discussion of this period will not be attempted here. Instead, it is necessary to mention only the key developments which may have affected the mammals of that period. Uerpmann (1975; 1990) suggests that the climatic shifts which took place during the later Atlantic to the Sub-Boreal in central Europe affected farming practices in such a way (i.e. a move to lake dwellings), as to leave open habitats (i.e. areas previously cleared of vegetation by humans) within the dry loess areas which the resident wild fauna could then exploit. Also, Uerpmann (1990) cites Frenzel's (1983) conclusion that during the early Neolithic of central Europe, the percentage of forest-free areas could have been as high as 40-50%. However, because deforestation was not as intense in some areas of Europe (e.g. Switzerland), more open habitats, which would have been preferable to specialised grazers such as horses, were lacking during this earlier period. In contrast, by the end of the Neolithic (c. 4,000 BP), the landscape in most areas of Europe had been significantly modified by agricultural practices (Adams, 1997), thus making the environmental reconstructions which post-date this period difficult to interpret.

3.4 Mammal faunas and their environmental associations

3.4.1 Introduction

Although the horses of the Mid-Late Devensian (or Weichselian) and Flandrian (or Holocene) periods are the main focus of the current project, it is important to mention the other mammal fauna which were extant at the time. What follows is a brief review of the wild and domestic animals which were typical of the subdivisions of the Late Glacial and Post Glacial given above and their supposed environmental associations (or habitat preferences) (table 3.5). For ease of comprehension, the long interval can be separated into two periods: the Late Glacial/early Post Glacial (c. 15,000-9,000 BP) and the Post Glacial (c 9,000 BP onwards) Firstly, it is important to remember that various sites of pre-Late Glacial or Middle Devensian age (i e. pre-c. 15,000 BP) in Britain and Europe have yielded mixed assemblages which include tundra (e g reindeer, lemmings) and steppe (e.g horse) species living contemporaneously within a particular area. An example of this mixed assemblage

Table 3 5. List of Relevant Mammal Fauna

WILD ANIMALS	*LINNEAN NAME*	ENVIRONMENTAL ASSOCIATIONS & HABITAT PREFERENCES
horse	*Equus ferus*	open steppe or steppe/tundra, open woodland
woolly rhinoceros	*Coelodonta antiquitatus*	open steppe or steppe/tundra
mammoth	*Mammuthus primigenius*	open steppe or steppe/tundra
reindeer	*Rangifer tarandus*	open steppe, steppe/tundra; boreal coniferous forest; tundra/taiga
red deer	*Cervus elaphus*	temperate and coniferous forests (IntGl); boreal forests (IntSt); treeless, herbaceous vegetation (St); steppe/tundra
roe deer	*Capreolus capreolus*	deciduous and coniferous forests; woodland with open areas
giant deer	*Megaloceros giganteus*	boreal or subarctic habitats; open woodland or open herbaceous
elk	*Alces alces*	temperate forest (IntGl); birch woodland (IntSt); taiga; open woodland with marshy woods
saiga antelope	*Saiga tatarica*	open (cold,arid) steppe; salt and loam steppe (p-d); sandhill country (p-d)
aurochs	*Bos primigenius*	open forest
chamois	*Rupicapra rupicapra*	open birch and pine forest; montane woodland and rocky slopes above tree-line (p-d)
musk ox	*Ovibos moschatus*	tundra
wild boar	*Sus scrofa*	temperate forests; regional birch/pine forest
bison ("steppe")	*Bison priscus*	open steppe (St); boreal forest (IntSt); locally deforested (IntGl)
bison* ("woodland")	*Bison bonasus*	mixed woodland with open areas
bison** ("tundra")	*Bison bonasus arbusto-tundrarum*	open steppe or tundra
lynx	*Lynx lynx*	woodland, montane regions
brown bear	*Ursus arctos*	chiefly forests
wolf	*Canis lupus*	open steppe or steppe/tundra; woods, open country with cover, mountainous regions, tundra (p-d)
arctic fox	*Alopex lagopus*	arctic regions: tundra, boreal forest
red fox	*Vulpes vulpes*	open environment with some coniferous woodland (IntGl & IntSt); variable habitats: dry country near scrub/woodland to forest and semi-open land (p-d)
steppe pika	*Ochotona pusilla*	steppe areas
arctic hare	*Lepus timidus*	forested areas (preferred to open country)
beaver	*Castor fiber*	aquatic habitats with adjacent deciduous woodland
Arctic lemming	*Dicrostonyx torquatus*	tundra
Norway lemming	*Lemmus lemmus*	tundra and boreal forest; taiga and spruce woods
DOMESTIC ANIMALS	***LINNEAN NAME***	
horse	*Equus caballus*	
domestic cow (ox)	*Bos taurus*	
domestic sheep/goat	*Ovis aries/Capra hircus*	
domesitc pig	*Sus scrofa*	
domestic dog	*Canis familiaris*	

Sources. Currant (1986, 1991), Lister (1994), Macdonald (1995); Stuart (1982); Turner (1990)

(p-d) present-day, (IntGl) Interglacial; (IntSt) Interstadial; (St) Stadial

sees the so-called "mammoth fauna" of Eurasia (i.e. the cold-tolerant mammalian species of the Devensian/Weichselian including present-day species of the tundra and steppe) flourishing in a "single hyperzone" of the tundra-steppe with tracts of forests along river valleys or in canyon bottoms of low mountain ranges (Vereshchagin and Baryshnikov, 1992). Equally important, however, is the transition from Middle Devensian to the Late Glacial/early Post Glacial (especially the Interstadial) in north-west Europe which was "marked by a unique combination of environmental parameters" which probably allowed "the temporary coexistence of otherwise unlikely combinations of mammalian species" (Currant, 1991).

An important question regarding the mammal faunas of the Late Glacial and Post Glacial is whether they act as good environmental indicators. It is well-known that the biostratigraphical and environmental evidence derived from pollen, fossil Mollusca and Coleoptera is relatively substantial and accurate. Because so much is known about the ecological requirements of extant mammalian communities, it is possible to predict (with caution) the requirements of Pleistocene species (i.e. palaeoecology), some of which are now extinct. This technique has been successfully implemented within Quaternary research (Stuart, 1982); however, it is necessary to stress that this practice must be used in conjunction with other environmental and climatic evidence gleaned from the non-mammalian taxa mentioned above as well as reliable radiocarbon dating evidence. For this reason, the review below takes into account all the available environmental and climatic evidence given above (section 3.3) as well as that from radiocarbon studies (e.g. Housley, 1991; see Appendix 1).

3.4.2 Faunas of Britain

Table 3.6 shows the mammal fauna (including horse) of Late Glacial and Post Glacial Britain in relation to the known chronostratigraphic and biostratigraphic subdivisions. It is evident from this table that during the Windermere Interstadial (c. 13,000-12,000 BP) a number of open habitat species such as horse, reindeer, arctic fox, mammoth and saiga antelope occur together with forest/woodland taxa such as red deer, elk, lynx and aurochs. Of course, this mixed assemblage is not always contemporaneous and probably reflects their different chronological distributions resulting from the changing climate and environment of the interval (see table 3.4). For example, elk is most often associated with the spread of birch woodland during this

Table 3.6. Mammal Faunas of the Late Glacial and Post Glacial of Britain

	^{14}C yrs BP	Pollen Zones	Typical Mammal Faunas: Britain	Additional Records: Dated Faunas & Sites
Flandrian Interglacial	1,000		horse pig beaver domestic cow domestic sheep goat	***lynx:*** ***(i.e. c.1.8k BP; Scotland)***
	2,500	Sub-Atlantic: VIII		
	4,000		horse wolf aurochs brown bear wild boar pig red deer domestic dog beaver domestic cow	***elk:*** ***(i.e. c.3.9k BP;Scotland)***
	5,000	Sub-Boreal: VIIb	aurochs pig red deer domestic cow (ox) domestic sheep goat	
	7,500	Atlantic: VIIa	aurochs red deer beaver roe deer wild boar brown bear wolf arctic hare pig domestic dog domestic cow domestic sheep goat	***elk:*** ***(i.e. c.5.7k BP;BI)***
	9,000	Later Boreal: VI	aurochs wild boar brown bear beaver red deer roe deer	***elk:*** ***(i.e. c.7.8k BP;Scotland)*** ***reindeer:*** ***(i.e. c.8.3k BP;Scotland)***
	9,500	Early Boreal: V	horse beaver red deer roe deer	***reindeer:*** ***(e.g. c.9.7k BP;AvH, DMC & GrC)***
	10,000	Pre-Boreal: IV	aurochs elk wild boar domestic dog	
Loch Lomond Stadial	10,500	Younger Dryas: III	horse reindeer lemmings (Arctic & Norway) steppe pika wolf	***red deer, aurochs & elk:*** ***(i.e. c.10k BP;3holes)*** ***(i.e. c.10.8k BP;SC)*** ***(i.e. c.10.9k BP;ChC)*** ***(e.g. c.11.0k BP;BS+PinH)***
	11,000			
Windermere Interstadial	11,500	Allerød: II	horse aurochs red deer giant deer arctic hare brown bear saiga elk wolf red fox lynx mammoth arctic fox	***reindeer:*** ***(e.g. c.11.0k BP;VC)*** ***(e.g. c.11.1k BP;T6)*** ***(e.g. c.11.6k BP;FF+VC)*** ***(e.g. c.11.9k BP;GC)*** ***(e.g. c.12k BP;FHC)*** ***(e.g. c.12.5k BP;AvH)***
	12,000	Older Dryas: Ic		
	12,500	Bølling: Ia & Ib		
	13 000			
	pre-14 000	Pre-Bølling	horse reindeer brown bear arctic hare	

British Sites referred to: AvH = Avelne's Hole, Somerset, BI = Barry's Island, N. Yorkshire; BS = Bart's Shelter, Cumbria; ChC = Chelm's Combe, Somerset, DMC = Dead Man's Cave, S. Yorkshire, FF = Feltwell Fen, Norfolk; FHC = Fox Hole Cave, Derbyshire; GC = Gough's Cave, Somerset; GrC = Green Craig, Lothian; PinH = Pin Hole Cave, Derbyshire; SC = Sewell's Cave, N Yorkshire; T6 = Torbryan 6, Devon, 3holes = Three Holes Cave, Devon, VC = Victoria Cave, N Yorkshire; Scotland (sites in Kitchener and Bonsall, 1997)

Majority of faunas listed actually date (i.e by ^{14}C) to relevant periods [see Appendix 1 & Housley (1991)].
Faunas in ***bold italics*** include other species of local occurrence not thought to occur typically in the relevant periods.

period (Lister, 1984), rather than the more open environments which would have suited horse and reindeer.

The Loch Lomond Stadial (c. 11,000-10,000 BP), on the other hand, was much depleted in faunal elements (table 3.6) The forest and temperate faunas of the previous interstadial were rare, and cold-tolerant, open habitat species such as lemmings, reindeer and horse flourished. It also seems natural to assume that this demanding environment also had a significant steppic component to it with the presence of steppe pika, wolf and horse, all three of which have been reliably radiocarbon-dated to this period (see tables in Appendix 1). The early Post Glacial (i.e. early Flandrian, c. 10,000-9,000 BP) saw the re-immigration of temperate and woodland elements (e.g. aurochs, beaver, roe deer) into a climate which was changing rapidly; while the environment was probably still in transition from an open to a closed one (table 3.4).

The Post Glacial period (c. 9,000 BP onwards) mainly consisted of wild mammals with distinct woodland components such as red deer, wild boar, beaver and aurochs. Horses, either wild or domestic, were conspicuously absent from assemblages dating c. 9,000-4,000 BP. However, at c. 4,000 BP, horses reappear in association with mainly wild mammals of a woodland or open woodland type (see above) and/or domestic mammals such as pig, cow and dog (table 3.6). See chapter 4 for a more in-depth discussion regarding horse distribution (e.g. chronological and geographical) in general and in relation to climatic and environmental factors.

In relation to the entire interval, from the Late Glacial through to the Post Glacial, several species, namely reindeer, elk, aurochs, red deer and lynx, appear rarely in certain assemblages (table 3 6) These assemblages are all radiocarbon dated to the relevant period; however, the unexpected presence of these species has consequences regarding the prevailing climate and available environments of the time For example, reliable radiocarbon dates for reindeer (see Appendix 1) allow it to be included as part of the mammal fauna in Britain (see sites listed in table 3.6) during two temperate episodes: the later Windermere Interstadial (c. 12,500-11,000 BP) and the early Flandrian (c. 9,700 BP [Pre-Boreal] and c 8,300 BP [Later Boreal]). This indicates, at least in certain areas/time intervals, that both the climate (cooler) and environment (more open) were probably suitable for reindeer survival. The environmental and climatic model depicted in table 3 4 is more complex, and highlights the necessity for emphasizing the flexibility within models over space and short time intervals as well as

within the animals themselves (e g. behavioural adaptations in response to changes in climate and environment).

3.4.3 Comparisons with continental north-west Europe

Table 3.7 shows the characteristic mammal fauna (including horse) of Late Glacial and Post Glacial continental Europe in relation to the known chronostratigraphic and biostratigraphic subdivisions. In contrast to the British model given in table 3.6, it is clear that mammal fauna present during the Late Glacial Interstadial appears less mixed. For example, the Bølling Interstadial consisted of mainly characteristic cold-tolerant mammals such as horse, mammoth, musk ox, the "steppe" bison (i.e. *Bison priscus*) and reindeer; while the Allerød Interstadial consisted of more temperate species (e.g. aurochs, beaver, red deer). This is significant because it highlights the presence of an assemblage distinctive of the Allerød Interstadial in continental north-west Europe. However, the same cannot be said for Britain where a clear distinction between the faunas of the Bølling and Allerød has not yet been proved. Furthermore, unlike Britain, an Older Dryas fauna was clearly evident on the Continent, and consisted mainly of cold-tolerant taxa such as reindeer and lemmings (table 3.7). Another difference relates to the composition of the faunal assemblages in the two regions. Certain species such as woolly rhinoceros, musk ox, chamois and "steppe" bison were all characteristic of the Bølling on the Continent, whereas in Britain, these species were entirely absent during the Late Glacial. Therefore, it seems likely that musk ox, woolly rhino and "steppe" bison did not survive the main stadial or "Glacial Maximum" of the Devensian (c. 20,000-15,000 BP) in Britain.

The Younger Dryas faunas of the two regions (i.e. Britain and north-west Europe) are very similar with the presence of mainly cold-tolerant species such as horse, lemmings and reindeer. Also, it is interesting that in both regions during the early part of the stadial (dated to c 11,000-10,700 BP) characteristic woodland/open woodland fauna such as elk, red deer and aurochs were present (tables 3.6 and 3.7). This scenario compares well with the model presented in table 3 4 for the Continent; however, it raises some interesting issues regarding the climate and environment of Britain during the early part of the stadial (i.e. the transition from Windermere Interstadial to Loch Lomond Stadial). For example, it is possible that some woodland persisted (i.e. as a result of the time lag in vegetational succession/response to

Table 3 7. Mammal Faunas of the Late Glacial and Post Glacial of Continental Europe

^{14}C yrs BP	Pollen Zones	Typical Mammal Faunas: Continental North-west Europe	Additional Records: Dated Faunas & Sites
1,000		horse	
2,500	Sub-Atlantic VIII		
4,000		horse	***bison***:* ***(i.e. Sub-Boreal/Sub-Atlantic, S.Scandinavia)***
5,000	Sub-Boreal· VIIb		
7,500	Atlantic: VIIa	horse	
9,000	Later Boreal. VI	elk aurochs	
9,500	Early Boreal: V	horse roe deer aurochs wild boar	
10,000	Pre-Boreal: IV	red deer beaver lynx elk bison* domestic dog	***reindeer:*** ***(i.e. Pre-Boreal; S.Scandinavia)***
10,500	Younger Dryas: III	horse bison** lemmings (Arctic & Norway) arctic hare steppe pika arctic fox reindeer	***giant deer & elk:*** ***(i.e. c.10.7k BP; S.Scandinavia)***
11,000			
11,500	Allerød: II	horse beaver red deer aurochs elk giant deer brown bear reindeer	
12 000	Older Dryas Ic	horse reindeer lemmings (Arctic & Norway)	
12,500	Bølling· Ia & Ib	horse arctic fox red deer mammoth reindeer wolf musk ox arctic hare chamois woolly rhino bison Arctic lemming	
13,000			
pre-14 000	Pre-Bølling	horse reindeer Arctic lemming	

Continental Sites referred to: S Scandinavia (sites in Aaris-Sørensen, 1992 & Degerbøl, 1964)

Dating of faunas to period from Street (1998), De Bie and Vermeersch (1998), Aaris-Sørensen (1992), Degerbøl (1964)

bison Bison priscus (Steppe bison), bison* *Bison bonasus* (European woodland bison), bison** "Danish tundra bison" (Degerbøl, 1964)

Faunas in ***bold italics*** include other species of local occurrence not thought occur typically in the relevant periods

deterioration in climate) in certain areas (possibly southern only), thus sustaining populations of aurochs and red deer during the late interstadial/early stadial. Furthermore, Degerbøl (1964) notes the presence during the Younger Dryas in north-west Europe of a 'type' of bison which he designates as the "Danish tundra bison" (= *Bison bonasus arbusto-tundrarum*). Conversely, in Britain, it appears that bison (*Bison* sp.) was not only entirely absent from Late Glacial faunal assemblages, but Post Glacial ones as well.

In contrast to the preceding interstadial and stadial, the characteristic fauna of the early Post Glacial (or beginning of the Flandrian Interglacial) for both regions is strikingly similar. All the temperate woodland/open woodland elements were present including aurochs, red deer, roe deer, wild boar, and elk (tables 3.6 and 3.7). Also, horse was present along with domestic dog which made its first appearance in British and European assemblages during the early Post Glacial (= Pre-Boreal and Early Boreal). Furthermore, reindeer, an unexpected element in a temperate wooded environment, was evident during this period (see British/European sites in tables 3.6 and 3.7; Aaris-Sørensen, 1992). In fact, radiocarbon dating confirms its presence in Britain for at least three different Pre-Boreal assemblages (e.g. Aveline's Hole, Dead Man's Cave, Green Craig: see Appendix 1). Consequently, Aaris-Sørensen (1992) stresses the importance of the phenomenon of a "time lag in vegetational response to amelioration" as having been key to mammal distribution during the transition from the stadial conditions of the Younger Dryas to the temperate conditions of the early interglacial. Also, interestingly, the only faunal element in which the two regions differ was the appearance on the Continent of the "woodland" bison (*Bison bonasus*) during the early Post Glacial. There is, at present, no record for this species in Post Glacial Britain.

It must be noted that the interpretations given above do not take account of the probable seasonal variation which existed regarding mammal distributions within the two regions. For example, even though certain taxa may be part of a contemporaneous assemblage this does not mean that they were present at a particular site during the same season (e g summer, winter). This highlights the need for a detailed review of well-dated faunal assemblages found at palaeontological/archaeological sites in Britain as well as on the Continent Although seasonal data for horses from British Late Glacial sites are rare (however, for an example of seasonality studies at Gough's Cave, Somerset see Beasley, 1987), the following chapter (chapter 4) attempts to create a

highly detailed review of horse distribution within Britain during the Late Glacial and Post Glacial periods. This will employ documented horse finds from key sites as well as reliable radiocarbon dates for well-stratified horse material from those sites. Also, a thorough review of their chronological and geographical distribution in relation to the prevailing climate and environment (see above) will be given in chapter 4 (section 4.7).

Table 3.8. References Used in Compiling Tables 3.1-3.7 and Figure 3.1

Stratigraphy, Chronology, Climate & Environments	**Mammal Fauna & Environmental Associations**
Adams (1997)	Aaris-Sørensen (1992) [CE]
Atkinson *et al.* (1987)	Currant (1986)
Barton *et al.* (1991)	Currant (1991)
Campbell (1977)	De Bie and Vermeersch (1998) [CE]
Coope (1977)	Degerbøl (1964) [CE]
Coope and Pennington (1977)	Gamble (1986)
Cox *et al.* (1976)	Grigson (1978) [BI]
Cunliffe (1993)	Grigson (1984) [BI]
De Bie and Vermeersch (1998)	Housley (1991) [BI]
Gordon (1988)	Kitchener and Bonsall (1997) [BI]
Gray and Lowe (1977)	Lister (1994)
Housley (1991)	Lowe and Walker (1984)
Iversen (1954)	Macdonald (1995)
Jacobi (1980)	Street (1998) [CE]
Lowe and Gray (1980)	Stuart (1982)
Lowe and Walker (1984)	Stuart (1991)
Lowe and Walker (1997)	Turner (1990) [CE]
Mangerud *et al.* (1974)	Vereshchagin and Baryshnikov (1992)
Megaw and Simpson (1984)	Also see: Appendix 1 [BI & CE]
Pennington (1977)	
Street (1998)	
Stuart (1991)	
Tolan-Smith (1998)	
Walker *et al.* (1994)	
Woodman *et al.* (1997)	
Wymer (1991)	

[BI] = British Isles; [CE] = Continental Europe

Chapter Four

Chronology and Distribution of Late Glacial and Post Glacial Horses in Britain and North-west Europe, and Their Relation to Environmental Factors

4.1 Introduction

Wild horses (*Equus ferus*), an integral component of the Late Pleistocene/early Holocene fauna in Britain and north-west Europe, are the principal focus of the present study. It is evident that horses occurred throughout the different periods of the Late Glacial (c. 15,000-10,000 BP) as well as the very early Holocene (c. 10,000-9,000 BP). However, during the Post Glacial, the emergence of true domestic horses (*Equus caballus*) becomes a consideration from which many questions arise. Specifically, was there a transition from wild to domestic horses during the Post Glacial in Britain? Or, did wild horses become extinct during the Boreal in Britain (c. 9,500-7,500 BP), only later (c. 4,000 BP) being replaced by foreign domestic stock? How does the British pattern of occurrence compare with that of horses on the Continent? These questions can only be answered via a thorough study of horse remains found at British sites and by the use of comparisons with relevant continental finds. Fossil and sub-fossil horse remains provide evidence of its presence at particular geographical locations as well as its wider distribution throughout Britain. Also, comparisons with continental horses of this period provide valuable information regarding the horse's geographical and chronological distribution further afield. By directly and actively investigating the available horse material, the present research aims to determine where, when and in what types of environments horses (both wild and domestic) lived during the British Late Glacial/Post Glacial. Furthermore, an important geographical and chronological survey of sites at which horse remains have been found was undertaken to determine distributional continuity. Particular attention was paid to the dating of relevant sites and finds via a radiocarbon programme which has provided 48 new dated horse specimens (see below).

4.2 Materials and Methods

Fossil horse material is available from both cave and open-air sites in Britain, and an exhaustive survey attempts to identify as many stratified sites as possible which have yielded horse material. Emphasis is placed on British bone caves, although some important open-air sites will be highlighted. These sites are reviewed below in relation to provenance, taphonomy, stratigraphy and dating, as well as climate, flora and fauna.

The author has visited collections in Great Britain and on the Continent in order to examine relevant material. After location, the sample size was determined and the material was identified and related to the stratigraphy of the sites concerned For the first time, a complete datelist of the horse in Britain during the Late Pleistocene to Holocene has been compiled using radiocarbon dates (both pre-existing and new). This horse datelist can then be compared to climate change during the Late Glacial/Post Glacial in order to test the question of the continuity of horses throughout Britain specifically, and north-west Europe generally.

In addition to England, Scotland and Wales, this project aims to briefly investigate the horse in Ireland by exploring its history there during the Late Pleistocene and Holocene in terms of specific sites, dates and land connections with Britain. The presence of the horse in Ireland was assessed mainly from a literature survey and radiocarbon dating studies. It is by no means a complete study of Irish horses but it marks a beginning: Irish Pleistocene and post-Pleistocene horses have never been directly compared to British ones in this manner.

Because a dating programme was undertaken in the current project, a separate section (section 4.5) has been dedicated to discussion of directly-dated horse specimens and their implications for distribution and continuity questions. The sites, horse material, and dates will be highlighted and discussed in relation to previous horse and non-horse dates from those sites The status of sites and horse material without dates will also be assessed

4 2 1 Sites and finds

Britain

Attempting to be comprehensive, the present author has personally examined most, if not all, of the known horse material from sites in Britain; however, due to time

constraints, some peripheral material (mainly from Post Glacial sites) has been investigated indirectly utilising the literature. In the current survey of Late Pleistocene/Holocene sites, the horse remains are the focus, but attention is also paid to provenance, stratigraphy and associated environmental indicators (i.e. fauna or pollen).

Below (section 4.3.2), a gazetteer of sites has been compiled. The primary aim of this list is to highlight the key British sites which have produced Late Glacial/early Post Glacial horse remains. The secondary aim of the list is to identify and summarise important British sites with horse material from both earlier and later periods (i.e. pre-15,000 BP and post-4,000 BP) as well as sites where horse is absent, an important undertaking that many previous workers have neglected. Thus, this work has segregated the sites into three key time periods: 1) Middle to Late Devensian (selected sites only, pre-15,000 years BP); 2) Late Glacial/early Post Glacial; and 3) middle to late Holocene (including the later Mesolithic, Neolithic, Bronze Age and Iron Age [selected sites only]). Within each time period, the sites have been separated further into regions (table 4.1 and fig. 4.1) followed by relevant counties (fig. 4.2). Each entry for the key British sites includes a detailed summary of important information concerning site history (e.g. type, excavation and collection), stratigraphy and associated finds (e.g. artefacts), dating of site and material (associated and direct), the author's identification of horse material, associated or additional fauna taken largely from the literature but with some revisions by the author (refer to table 4.2), key references and museum collections most of which were visited by the author (table 4.3). Among these sites, some are deemed as especially important due to detailed study (e.g. measurement and identification of specimens by the author) or radiocarbon dating which has been undertaken by either the present author or other workers. Secondary sites will be summarised briefly, and only the information relevant to the current project will be included (e.g. identification of horse and/or site dating). Finally, sites without horse material will be dealt with separately in section 4.3.4.

Ireland

The gazetteer of Irish sites which has been compiled below (section 4 3.3) aims to identify, highlight, and summarise a selection of key sites which have produced Late Pleistocene to Holocene horse remains. The sites have not been segregated into time periods, however, they have been separated into regions (table 4 1) Priority is given to Irish sites which either have directly-dated horse remains (via the present or previous

Table 4 1. Region Key

Region No.	Regional Divisions of England (1 to 10)
1	THE NORTHERN COUNTIES Northumberland; Tyne-and-Wear; Cumbria; Durham; (Cleveland- Northwest)
2	THE LANCASHIRE/CHESHIRE REGION Lancashire; Greater Manchester; Merseyside; Cheshire
3	YORKSHIRE North Yorkshire; West Yorkshire; South Yorkshire; (Cleveland- Southeast); (Humberside North)
4	THE SEVERN VALLEY & WEST MIDLANDS Shropshire; Staffordshire; West Midlands; Warwickshire; Hereford & Worcester; Gloucestershire
5	THE EAST MIDLANDS Derbyshire; Nottinghamshire; Lincolnshire; Leicestershire; (Humberside- South)
6	THE SOUTH MIDLANDS & THE UPPER THAMES Northamptonshire; Bedfordshire; Buckinghamshire; Oxfordshire; Hertfordshire; (Greater London- Northwest: i.e. 'Middlesex')
7	THE EASTERN COUTIES Cambridgeshire; Norfolk; Suffolk; Essex; (Greater London- Northeast: i.e. 'Essex')
8	THE SOUTH WEST Cornwall; Devon; Isles of Scilly
9	WESSEX Somerset; Dorset; Hampshire; Berkshire; Wiltshire; Avon
10	THE SOUTH EAST (Greater London- South of Thames); Surrey; Kent; West Sussex; East Sussex
Region No.	**Regional Divisions of Scotland, Wales and Ireland (11 to 18)**
11	SOUTHERN & CENTRAL SCOTLAND Dumfries and Galloway; Borders; Lothian; Strathclyde; Central; Fife
12	NORTHERN SCOTLAND Tayside; Grampian; Highland; Shetland; Orkney; Western Isles
13	SOUTHERN & CENTRAL WALES Dyfed; West Glamorgan; Mid Glamorgan; South Glamorgan; Gwent; Powys
14	NORTHERN WALES Gwynedd; Clwyd
15	IRELAND - ULSTER [North] Donegal; Londonderry; Antrim; Tyrone; Down; Armagh; Fermanagh; Monaghan; Cavan
16	IRELAND - CONNACHT [West] Leitrim; Roscommon; Sligo; Mayo; Galway
17	IRELAND - LEINSTER [East] Louth, Longford; Meath; Westmeath; Dublin, Offaly; Kildare; Leix; Wicklow; Carlow; Kilkenny Wexford
18	IRELAND - MUNSTER [South] Clare Tipperary; Waterford Limerick; Cork Kerry

English counties in parentheses are in more than one region, regionalization of England from Cunliffe (1993); regionalization of Scotland, Wales, Ireland by the current author

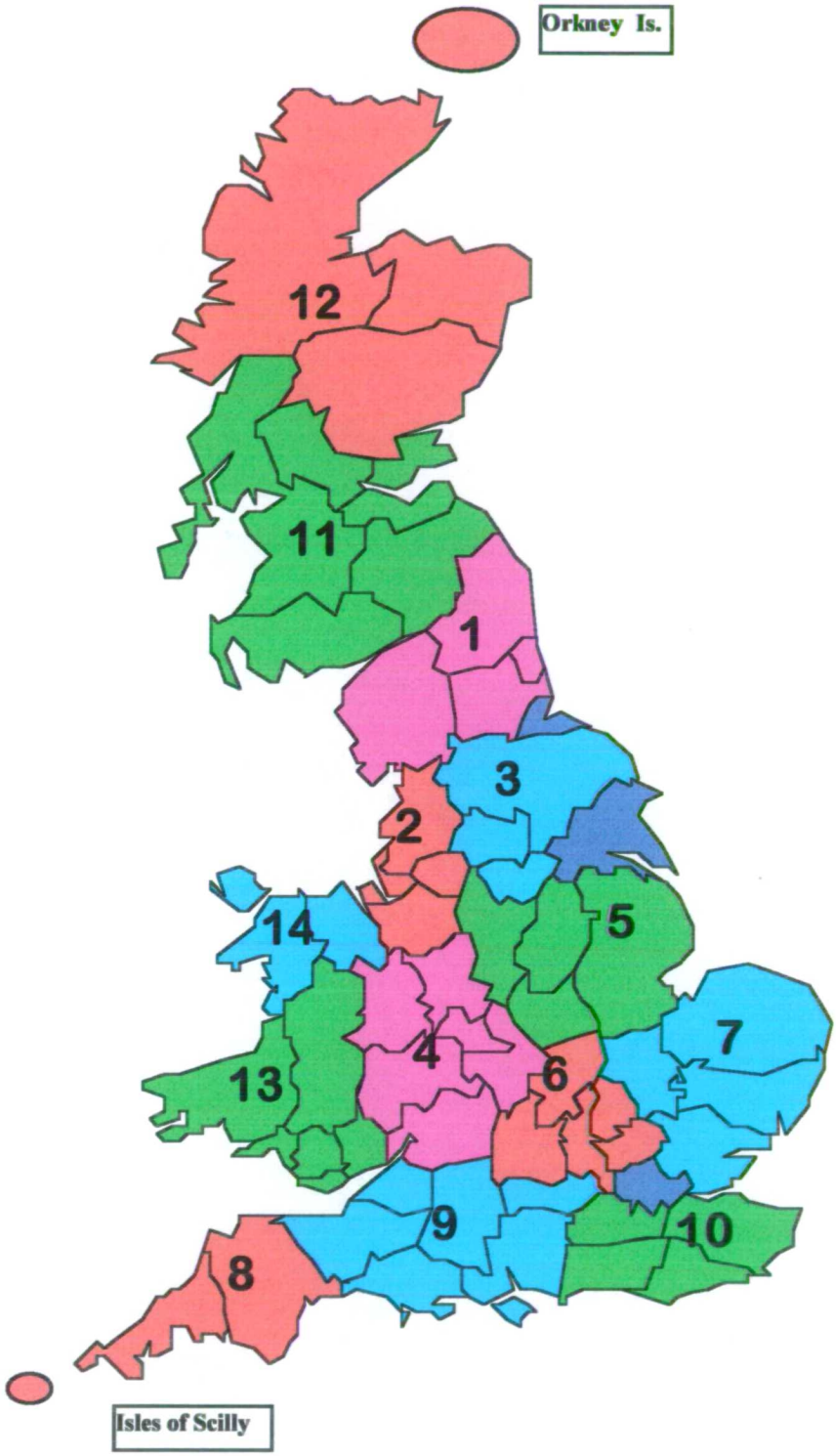

Fig. 4.1. Map of the U.K. with all relevant regions highlighted and numbered (see Table 4.1). (counties shaded dark blue are shared between regions).

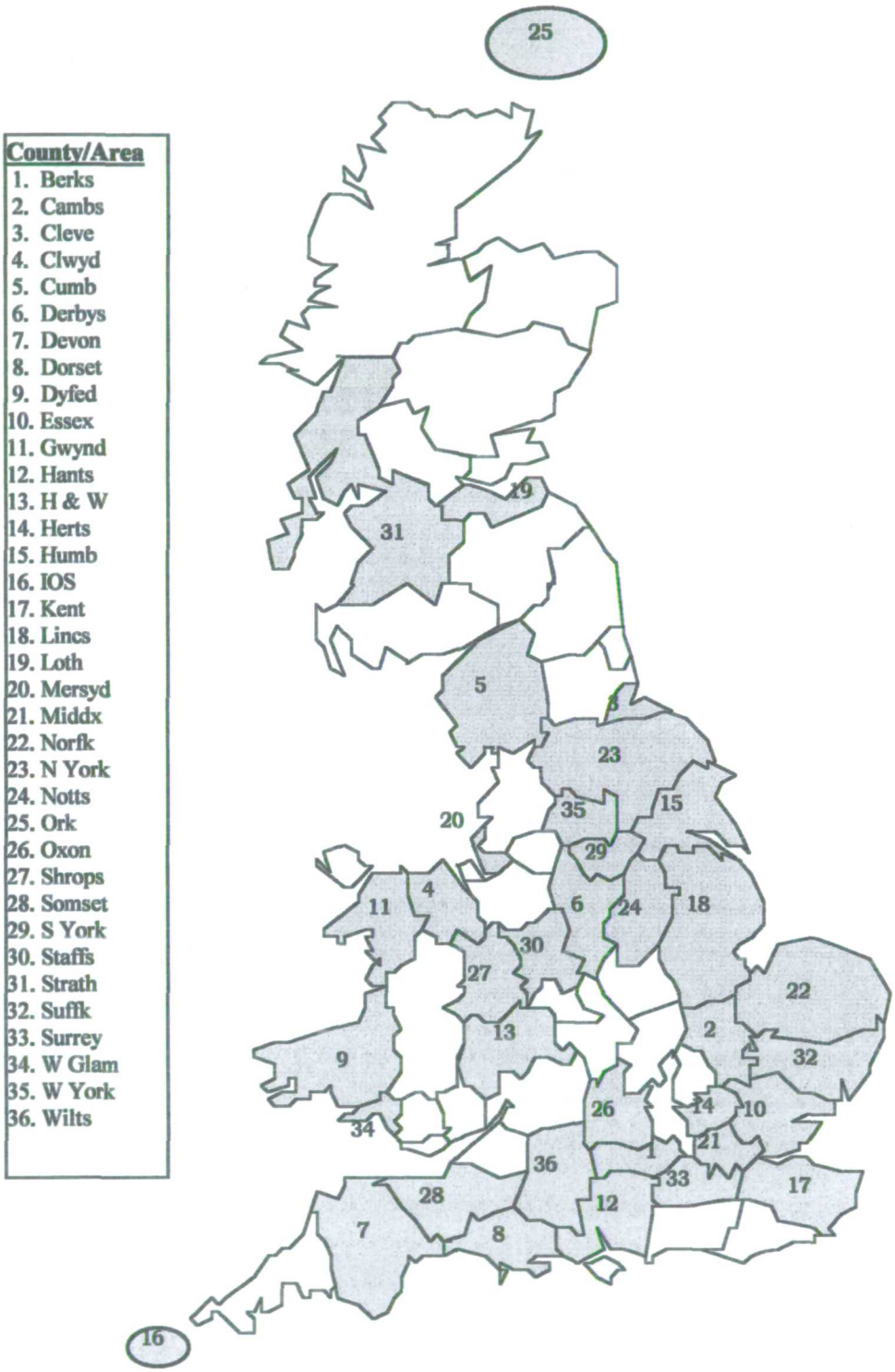

Fig. 4.2. Relevant U.K. counties and/or areas. The thirty-six listed in the table are represented on the map as numbered, shaded areas.

Table 4.2. Mammalian Fauna Mentioned in the Gazetteers: *Linnean name* - common name

Order Lagomorpha	
Family Ochotonidae	
Ochotona pusilla	steppe or cave pika
Family Leporidae	
Lepus timidus	Arctic, 'varying', 'blue', or 'mountain' hare
Lepus europaeus (or capensis)	common or brown hare
Oryctolagus cuniculus	European rabbit
Order Rodentia	
Family Castoridae	
Castor fiber	beaver
Family Muridae	
Lemmus lemmus	Norway lemming
Dicrostonyx torquatus	Arctic or collared lemming
Arvicola terrestris	water vole
Microtus arvalis	common vole
Microtus agrestis	short-tailed vole
Microtus oeconomus	northern vole
Microtus gregalis	tundra or narrow-skulled vole
Microtus ratticeps	root vole
Clethrionomys glareolus	bank vole
Apodemus sylvaticus	wood mouse
Apodemus flavicollis	yellow-necked mouse
Cricetus cricetus	common hamster
Family Sciuridae	
Citellus superciliosus	European suslik
Family Zapodidae	
Sicista betulina	northern birch mouse
Order Insectivora	
Family Soricidae	
Sorex araneus	common shrew
Sorex minutus	pygmy shrew
Neomys fodiens	Eurasian water shrew
Family Erinaceidae	
Erinaceus europeus	hedgehog
Family Talpidae	
Talpa europea	mole
Galemys sp	desman
Order Carnivora	
Family Mustelidae	
Mustela erminea	stoat
Mustela putoris	polecat
Mustela nivalis	weasel
Meles meles	badger
Martes martes	pine marten
Lutra lutra	otter
Gulo gulo	glutton or wolverine

Table 4.2. Mammalian Fauna Mentioned in the Gazetteers: *Linnean name* - common name (continued)

Order Carnivora (continued)	
Family Canidae	
Canis lupus	wolf
Canis familiaris	domestic dog
Alopex lagopus	Arctic fox
Vulpes vulpes	red fox
Family Ursidae	
Ursus arctos	brown bear
Ursus spelaeus	cave bear
Family Felidae	
Lynx lynx	northern lynx
Panthera (Felis) leo	lion
Felis sylvestris	wild cat
Felis catus	domestic cat
Family Hyaenidae	
Crocuta crocuta	spotted hyaena
Order Perissodactyla (excluding Family Equidae)	
Family Rhinocerotidae	
Coelodonta antiquitatus	woolly rhinoceros
Dicerorhinus hemitoechus	narrow-nosed rhinoceros
Order Artiodactlya	
Family Cervidae	
Cervus elaphus	red deer
Rangifer tarandus	reindeer
Capreolus capreolus	roe deer
Megaloceros giganteus	giant deer
Alces alces	elk or moose
Dama dama	fallow deer
Family Bovidae	
Bos primigenius	aurochs or wild cattle
Bos taurus	domestic cattle or ox
Bison priscus	bison
Ovibos moschatus	musk ox
Saiga tatarica	saiga antelope
Sus scrofa	wild boar and domestic pig
Ovis aries	domestic sheep
Capra hircus	domestic goat
Capra ibex	ibex
Rupicapra rupicapra	chamois
Order Proboscidea	
Family Elephantidae	
Mammuthus primigenius	woolly mammoth

Table 4 3 Museums Visited

Abbr.	Name of Museum: Britain
CUMAA	Archaeology & Anthropology Museum, University of Cambridge
BPRC	Baden Powell Research Centre, Oxford
BBM	Brighton Booth Museum
BGSM	British Geological Survey, Keyworth, Nottingham
BMFH	British Museum, Frank's House
BMAG	Buxton Museum & Art Gallery
CCM	Cheddar Caves Museum, Somerset
CCVC	Creswell Crags Visitor Centre, Derbyshire
DM	Devizes Museum
DCM	Dorset County Museum
HZM	Harrison Zoological Museum, Sevenoaks, Kent
IM	Ipswich Museum
MM	Manchester Museum
MOL	Museum of London
NMW	National Museum of Wales, Cardiff
NHM	Natural History Museum, London
RMAG	Reading Museum & Art Gallery
SSWM	Salisbury & South Wiltshire Museum, Salisbury
SMR	Scarborough Museum (The Rotunda)
SMC	Sedgwick Museum, Cambridge
SOTMAG	Stoke-on-Trent Museum & Art Gallery
SAU	Suffolk Archaeology Unit, Bury-St-Edmunds
UBSSM	University of Bristol Spelaeological Society Museum, Bristol
WM	Wells Musuem, Wells
YM	Yorkshire Museum, York
Abbr.	**Name of Museum: Continent**
IRScNB	IRScNB, Brussels, Belgium
RGZSM	Römisch-Germanisches Zentralmuseum, Schloss Monrepos, Neuwied, Germany
MDPS	Musée Départemental de Préhistoire de Solutré, Solutré, France
IUFAT	Institute fur Ur- und Fruhgeschichte, Archäobiologie (H.-P. Uerpmann's Lab), Tübingen, Germany

radiocarbon dating projects) or have associated dates which make the assemblage relevant to aspects of the current project. See section 4.5.2 (especially *Overview and Conclusions*) for a summary of chronological comparisons between Britain and Ireland. Furthermore, some sites are included because of their importance in the morphological comparisons that can be made between British and Irish Pleistocene/Holocene horses (see chapter 5). Only a few of the horse collections listed were studied personally by the author, and consequently much of the information was taken from the literature. As with many of the British sites, each entry in this section includes a brief summary of information concerning site history (e g. type, excavation and collection), stratigraphy and associated finds (e g. artefacts), dating of site and material (associated and direct), the identification of horse material, associated or additional fauna, and key references.

Continental Europe

The gazetteer in section 4.4 2 takes into account key north-west European sites with horse which the author has personally investigated. It is important to mention that this directory is by no means definitive, and only sites (mainly of Late Glacial/early Post Glacial age) relevant to the present study are highlighted and summarised. Other sites located in north-west Europe and the rest of Europe which also warrant a mention in relation the wider chronological aspects of the current study (i.e. Late Pleistocene to Holocene sites with horse) are listed in a more generalised European site list (table 4.4 and see section 4.5.3). The majority of these sites are deemed as important based strictly on the information (e.g. published measurements and/or dates on horse) gleaned from an extensive literature survey. Comparisons concerning the chronology, geography and morphology of these horses and those from British and Irish sites will be made later in this chapter (sections 4.5.4, 4.6) as well as in chapter 5.

As with the British and Irish sites above, each entry in this section includes a summary of information concerning site history (e.g. type, excavation and collection), stratigraphy and associated finds (e.g. artefacts), dating of site and material (associated and direct: some of which has been undertaken by the present author), the identification of horse material, associated or additional fauna taken mainly from the literature (refer to table 4.2), and key references and museum collections all visited by the author (table 4.3). The entries below (section 4.4.2) are segregated by country.

4.2.2 Radiocarbon dates and dating

Radiocarbon determinations quoted throughout this thesis are given in uncalibrated radiocarbon years (± the error estimate) before the present (BP), where the 'present' is set at AD 1950. All radiocarbon ages are based on the Libby half-life for radiocarbon (^{14}C) of 5,570 years (Barton *et al.*, 1991) The majority of dates related here were produced either by conventional or Accelerator Mass Spectrometry (AMS) methods for tooth and bone (Gillespie, 1986; Pilcher, 1991a), and in some cases by both. Although the dated material consists mainly of bone and tooth, other sources used (e g dung) are also mentioned

In this and other chapters, a distinction is made between reliable and unreliable radiocarbon dates. The author considers dates to be unreliable if original samples consisted of mixed species bulked, or burnt/charred material. Also, dates obtained from specimens low in collagen are treated as unreliable. With respect to horse finds,

Table 4 4 European Sites with Horse Material

Mid-Late Weichselian			
French Sites	**Belgian Sites**	**Sites from Other Countries**	
Camiac (Weichselian) Combe-Grenal (Weichselian) Jaurens (Weichselian) Pair-non-Pair (Weichselian)	Flemish Valley (various)	**Brinzeni Cave, Moldavia (c. 20,000 BP); Ciuntu Cave, Moldavia (c. 20,000 BP)**; Kamenka, Siberia (c 30,000 BP); **Kostjenki, Russia (20,000-11,000 BP)**; Mezin, Russia (c. 24,000 BP), Risovaca, Serbia (c 36,000 BP); Sandalja II Cave, 'Yugoslavia' (Upper "Wurmian"(a-h))	
Late Glacial to Early Post Glacial			
French Sites	**German Sites**	**Belgian Sites**	**Sites from Other Countries**
***Bruniquel (= Courbet)** **Belloy-sur-Somme** Closeau **Etiolles/Les Coudrays** **La Fru** **Le Grand Canton** **Le Tureau des Gardes** Pont D'Ambon ***Solutré**	***Andernach-Martinsberg** *Bedburg-Königshoven Endingen ***Gönnersdorf** *Kartstein Abri **Kaster**; *Kettig **Kniegrotte** Lausnitz Cave, Orla Meiendorf *Miesenheim II *Niederbieber **Oelknitz; Petersfels** **Sesselfelsgrotte** Spitzbubenhöhle Stellmoor	Grotte de Remouchamps **Grotte de Sy Verlaine** **Grotte du Coléoptère** Trou Balleux **Trou des Blaireaux** ***Trou de Chaleux** **Trou du Frontal, Furfooz** **Trou des Nutons, Furfooz**	**Rheinfelden-Eremitage, Switzerland** **Birseck-Eremitage, Switzerland** **Pekárna-Höhle, Czech Republic**
Middle Holocene (Mesolithic/Neolithic/Bronze Age)			
French & German Sites		**Sites from Other Countries**	
Roucadour, France (Neo-Bronze Age), Bondebruck, Germany (Meso); **Bruchsal-Aue, Germany (Neo)**; Calden, Germany (Neo); Dümmersee, Germany (Neo), Henauhof NW, Germany (Meso); Hohen Viecheln, Germany (Meso); Rüde, Germany (Meso); **Schwanfeld, Germany (E.Neo)**		Föllik, Burgenland, Austria (Neo); **Lindskov, Denmark (Mid-Neo)**; Csepel-Háros, Hungary (E. Bronze Age), Hekelingen, Netherlands (Neo); nr. Hardenberg, Netherlands (Neo); Molenaarsgraaf, Netherlands (Neo); Swifterbant, Netherlands (Neo); Zambujal, Portugal (Neo/Beaker/Bronze Age); **Cueva de la Carigüela, Spain** (Meso/E. Neo); **Moncin, Spain (Late Bronze Age)**; Bokarn, Sweden (Bronze Age); Lövsta, Sweden (Bronze Age); Ullunda, Sweden (E. Bronze Age); **Auvernier, Switzerland (Late Bronze Age)**; Dereivka, Ukraine (Eneolithic)	

Sites in **BOLD** – with dated horse, *= see entry in gazetteer of sites this chapter

in particular, the author does not consider these types of determinations to be truly representative of the age of the specimens, and there is a possibility that the dates might have been contaminated (e g. by the older or younger non-horse material). Although unreliable dates will not be used as a critical source of information, the author has chosen not to ignore them completely. They can be used with caution as a rough guide to the age of the horses as well as the non-horse fauna and relevant artefacts.

Two types of dating table are referred to throughout the present chapter, one for directly dated horse specimens and one for associated or general site dates. Dates relevant to the current project fall into four categories:

1. Previous[1] (i.e. those obtained previously by other researchers and published in the literature) direct radiocarbon dates on horses from the Mid-Devensian to the Post Glacial period in Britain/Ireland and continental Europe (see tables in Appendix 1).
2. New (i.e. those obtained as part of the current project) direct radiocarbon dates on horses from this period in Britain/Ireland and continental Europe (table 4.5).
3. Previous bulked radiocarbon dates on samples which include horse only or horse plus other species.
4. Previous radiocarbon dates on sites from which the horse samples have come. These are sometimes 'associated' with the horse, in the sense that they come from the same stratigraphic unit; or may come from other horizons at the site and so provide some constraint on the age of the horse material (see table in Appendix 1).

Sites and specimens for the current radiocarbon dating project were selected according to some or all of the following criteria: 1) Horse fossils from museum and private collections available for sampling had not been preserved or treated in a way that would interfere with radiocarbon measurement; 2) Information was available on the horizon of origin of the horse remains; 3) The site has provided some indication of age suggesting that the horse material dates from one or more of the time periods of interest in this project. This information may derive from associated radiocarbon dates, archaeology, or biostratigraphy (e g. associated fauna); 4) The horse material displays evidence of human modification (e.g. cutmarks resulting from butchery); and 5) At sites for which previously obtained horse or bulked dates were available, new dates

[1] All previous dates were obtained via a literature search and personal communications (i.e. unpublished dates). The journals *Archaeometry* and *Radiocarbon* provided the majority of published dates (see Appendix 1).

Table 4.5. New Radiocarbon Dates Obtained by the Current Author for Horse Material from British/Irish and Continental Sites

Lab No.	Site with Dated Horse Material	Radiocarbon Date	
		^{14}C Date (BP)	Error ±
OxA-6671	Aveline's Hole	10,220	90
OxA-6632	Bridged Pot Shelter	10,810	75
OxA-6667	Brunquel (Courbet), France	13,230	90
OxA-6314	Cathole Cave, Wales	12,180	90
OxA-6637	Chelm's Combe	10,665	65
OxA-6317	Clevedon Cave	28,900	550
OxA-6326	Dead Man's Cave	11,800	100
OxA-6327	Dead Man's Cave	11,630	100
OxA-6325	Dog Hole Fissure	1,720	90
OxA-6613	Durrington Walls	2,500	45
OxA-6614	Durrington Walls	2,090	45
OxA-6653	Durrington Walls	3,045	50
OxA-6320	Elderbush Cave	33,050	1000
OxA-6322	Feltwell Fen	330	90
OxA-6318	Flixton site II	10,090	90
OxA-6319	Flixton site II	10,150	80
OxA-6310	Fox Hole Cave	11,920	130
OxA-6311	Fox Hole Cave	12,030	90
OxA-6312	Fox Hole Cave	10,980	90
OxA-6313	Fox Hole Cave	10,770	90
OxA-6654	Fussell's Lodge Long Barrow	2,940	50
OxA-6668	Gough's Cave	1,190	40
OxA-6309	Kendrick's Cave	1,045	65
OxA-6473	Kendrick's Cave	205	45
OxA-6669	Kent's Cavern	12,330	90
OxA-6754	Killuragh Cave, Ireland	3,020	45
OxA-6631	King Arthur's Cave	12,000	80
OxA-6732	King Arthur's Cave	12,150	100
OxA-6733	King Arthur's Cave	12,230	100
OxA-6734	King Arthur's Cave	13,320	130
OxA-6656	Maiden Castle	2,290	45
OxA-6657	Maiden Castle	1,015	40
OxA-6666	Mother Grundy's Parlour	12,040	80
OxA-6735	Mother Grundy's Parlour	11,910	110
OxA-6321	Moughton Fell Cave	11,070	100
OxA-6670	Neale's Cave	10,420	75
OxA-6316	Ossom's Cave	10,920	90
OxA-6323	Robin Hood's Cave	10,460	90
OxA-6324	Robin Hood's Cave	12,210	100
OxA-6636	Sewell's Cave	10,715	75
OxA-6730	Solutré, France	15,080	130
OxA-6731	Solutré, France	14,570	130
OxA-6315	Sproughton	10,290	100
OxA-6655	Swaffham Fen	635	40
OxA-6658	Thatcham site I	285	40
OxA-6634	Victoria Cave	1,740	40
OxA-6633	Wolf's Den	10,125	70
OxA-6635	Woolwich Green Gravel Pit	1,550	40

were needed to clarify previous unreliable ones as well as providing supplementary ones.

The newly-dated material is of two kinds: bone and tooth. Due to the small size of many of these specimens and the importance of many of them as archaeological relicts (some of which retain significant information such as cut-marks which indicate a human/animal association), the analyses were done by the AMS method (e.g. Gillespie, 1986; Pilcher, 1991a) at the Oxford Radiocarbon Accelerator Unit (ORAU). This advanced procedure is more attractive to curators and researchers since it only requires the use of only a few grams of bone or tooth rather than the destruction of an entire specimen as is the case with conventional radiocarbon dating. Also, because the mineral component is subject to pre- and post-excavational exchange, dating of collagen, or even of selected amino-acids, was preferred. The sampling procedure involved a small amount of drilling into a specimen (e.g. the root of a tooth), which was carried out at either the NHM or the ORAU, in order to remove 1-2g of material for accelerator dating. Many of the specimens were already broken and the sample was taken from the damaged area, thus preserving the pristine areas (i.e. to cause minimal damage). In many cases, the number of suitable specimens available from a given horizon was small, often just one or two pieces. Also, every attempt was made to ascertain the preservational history of specimens since excavation (e.g. method of storage in museum collections, extent of preservative treatment); however, even if organic preservatives had been applied, usable samples were obtainable from deeper within specimens where the preservative had not reached. For this reason (and for their generally greater integrity) teeth as samples were preferred to bones. Ultimately, the main objective was to favour, where possible, untreated and well-preserved specimens for dating.

4.3 Review of relevant Late Pleistocene and Holocene sites in Britain and Ireland

4 3 1 Introduction

The study of faunal material from palaeontological and archaeological deposits in Britain has undergone many changes in techniques and approach. Some of the first British cave investigations were carried out in the early 19th century by people such as Buckland (Paviland Cave, 1823) and MacEnery (Kent's Cavern, 1825-29) Davis (1987) notes that by the late 19th century, excavators such as Pitt-Rivers and Pengelly

(Kent's Cavern, 1865-80) were paying much more attention to careful excavation techniques in order to preserve all the finds, especially the faunal remains. Garrod (1926) was one of the first workers to carefully classify the archaeological material from all the Upper Palaeolithic sites and collections in Britain known to her. Although Garrod's account is an invaluable tool in the study of Upper Palaeolithic sites and finds, the terminology is dated and is in much need of revision. Also, at this time, the importance of site stratigraphy was still not well understood, and it was not until later in the 20th century that excavators would refine and improve dating methods as well as develop new techniques of environmental reconstruction.

The more recent works of Campbell (1977), Grigson (1978) and Stuart (1982) have aided in the revision of Garrod's work, primarily by increasing the number of recorded sites of Late Pleistocene age. Campbell's (1977) appraisal of Upper Palaeolithic material in Britain using granulometric, faunal and pollen analysis as well as radiocarbon dating evidence serves as a primary source of information concerning Late Glacial sites investigated in the current research. Even though his faunal study included a survey of samples in museum collections held in England and Wales, literature reviews and his own excavations (in 1968/69) of both cave and open sites in England and Wales, this work is in no way detailed enough with respect to the horse remains. Similarly, Grigson's (1978) account of ungulate fauna (including horse) from British Late Glacial/early Post Glacial sites is by no means a complete site record and stems almost exclusively from a literature review (pre-1976).

Hamilton's (1976) thesis, *The Horse in Prehistoric Times in the British Isles and Adjacent Areas of Europe* and Neil's (1977) thesis, *The Exploitation of Equids in Post-Glacial Britain and Ireland, to the Early Iron Age* require a mention. Both authors in their respective theses attempted to investigate horse finds from the Late Glacial/Post Glacial period; however, neither successfully completed the linking of find references in the literature to the finds themselves. Hamilton (1976) relied exclusively on a literature survey; while Neil (1977) combined his catalogue of sites compiled from library work with an insufficient examination of extant material (e g. taking selective measurements) Therefore, some 20 years on, applying some of Campbell's (1977) and Grigson's (1978) methods for generalised faunal reconstructions (e g. secure identification and dating of individual specimens), and Neil's (1977) and Hamilton's (1976) methods for focusing on a single species, the present work is the first to

thoroughly and directly investigate the horse in Britain during the Late Glacial to Post Glacial.

There are seven key objectives which make this survey unique compared to those done previously:

- Direct location of horse material in palaeontological/archaeological collections
- Identification of new and existing material in collections and corroboration with published/unpublished references and personal communications
- Assessment of sample sizes and preservation state of material
- Measurement and detailed study of individual specimens (see chapter 5)
- Identification of key specimens which have been previously dated or are in need of dating
- Relation of individual specimens to provenance, stratigraphy, associated fauna, archaeology
- Assessment of intra- and inter-site comparisons (e.g. sample size, dating, geography)
- Direct radiocarbon dating of individual specimens (see section 4.5)

4.3.2 Gazetteer of sites including a survey of their horse remains and existing dating evidence: Britain

Selected sites with horse material: Middle to Late Devensian (excluding specifically Late Glacial sites)

Region 4:

Elderbush Cave, Wetton, Staffordshire [SK 097 548], References: Bramwell (1964, 1973); Campbell (1977)

A cave site in the Manifold Valley excavated by Wilson and Bramwell in 1935-52 for the Peakland Archaeological Society. An extensive stratigraphic sequence was uncovered and the red cave-earth deposit (Layer 9) was distinguished as the chief bone-bearing level. However, Bramwell (1964) notes that there was no clear separation of lower and upper levels of Layer 9 even though this layer contained finds from a wide range of Late Pleistocene mammalian species. Bramwell (1964) also notes that deposits of Layer 11 and the upper stalagmite layers represent the "Late Glacial rather than the Full Glacial stage". The bulk of the faunal collection is conserved in the

BMAG but some fauna excluding horse is held at the SOTMAG. The finds include LUP (Layer SB or "Layer 10") artefacts and a possible "burial/cache of the thoracic region of a young reindeer under limestone slabs" near the cave entrance (Campbell, 1977). A subsequent radiocarbon date (Appendix 1) from Layer 10 supports the presence of Late Glacial deposits (c.10,600 BP).

Bramwell (1964) notes the presence of at least one individual of horse based on fossil remains found in lower Layer 9. Horse remains appear to be absent from the upper layers dating to the Late Glacial (Bramwell, 1964). The present author has studied all the available horse remains from Elderbush Cave and one radiocarbon date (table 4.5) on a metapodial from Layer 9 obtained as part of the current project lies within the Middle Devensian (c. 33,000 BP). A full discussion of the implications of these studies is discussed in section 4.5.2. The associated mammal remains from lower Layer 9 are thought to include a mixed assemblage of hyaena, lion, bison, woolly rhinoceros, cave and brown bear, reindeer, lemmings, wolf, and "common" or red fox (Bramwell, 1964).

Merlin's Cave (or 'Great Doward Cave'), Wye Valley, Hereford and Worcester, References: Hewer (1924), Hinton (1925)

A cave site in the Wye Valley with a supposed Late Pleistocene (perhaps Late Glacial) faunal assemblage. According to Hinton (1925), the fauna is very similar in composition to that found in the Yellow Rubble level at King Arthur's Cave, also in the Wye Valley. Horse is listed among the faunal remains, but only one bone (a complete left tibia: W1/no number) was located and studied by the author in the collections at the UBSSM. The mammalian faunal remains are thought to include aurochs, beaver, lemmings, voles, and steppe pika. However, these remains, some of which are indicative of the Late Glacial in Britain (e g lemmings and pika), were not located by the author at the UBSSM. One radiocarbon date (Appendix 1) is available for pika remains, and supports a later Late Glacial age (c. 10,000 BP) for the assemblage. The horse bone was found by the author in a box which also held some other ungulate (perhaps sheep/ox/cervid) bones The horse bone was large and seemed to be highly mineralised as did one of the other unidentified ungulate bones, presumably indicative of Pleistocene age.

Region 5:

Church Hole Cave, Holbeck, Nottinghamshire [SK 534 741], References: Dawkins (1877); Mello (1877); Garrod (1926); Campbell (1977); Grigson (1978); Jenkinson (1984); Gowlett *et al.* (1986b); Hedges *et al.* (1996: AM22)

A cave site within the Creswell Crags gorge originally excavated by Dawkins and Mello in 1875/6; however, more recent investigations of the cave deposits were carried out in 1978-79 (Hedges *et al.*, 1996: AM22). Finds from the above excavations include Devensian mammalian remains and LUP artefacts, one of which is made from a reindeer antler; however, Grigson (1978) notes Garrod's (1926) suggestion that the Mousterian and Upper Palaeolithic levels are mixed. The faunal collection is conserved at the NHM and MM. Some specimens from the 1875/6 excavations are conserved in the CCVC. Radiocarbon dated fauna (Appendix 1) range in age from the Mid-Late Devensian (c. 26,900-24,000 BP) to the Late Glacial (c. 12,300-12,100 BP) (Gowlett *et al.*, 1986b; Hedges *et al.*, 1996: AM22).

Horse remains are present from the Devensian deposits at Church Hole and the present author has studied a small sample of postcranial elements from the 1876 excavation held at MM. Other Devensian faunal remains include hyaena, arctic hare (Late Glacial), red fox, brown bear, woolly rhinoceros and arctic lemming. This list is not complete.

Ash Tree Cave, Whitwell, Derbyshire [SK 515 761], References: Armstrong (1957); Campbell (1977); Jenkinson (1984); Hedges *et al.* (1996: AM22)

A cave site excavated by Armstrong in 1949-56 and by McBurney in 1959-60. Finds from the excavations include possible EUP artefacts as well as Late Pleistocene mammalian faunal remains. Also, Campbell (1977) notes that the supposed "Creswellian" artefacts include tools of Mesolithic and Neolithic aspect. Two radiocarbon dates (Appendix 1) for faunal material are considered Mid-Late Devensian or earlier (c. 40,500 BP and c. 25,700 BP), while one for human remains lies within the Late Neolithic/Early Bronze Age (c 3,700 BP) (Hedges *et al.*, 1996. AM22).

Horse is supposedly present at Ash Tree Cave (Jenkinson, 1984), but it is unknown whether the remains are associated with Late Pleistocene or Holocene deposits The Devensian faunal assemblage is thought to include bison, reindeer, wolf, red fox, wolverine (or glutton) and brown bear (Hedges *et al.*, 1996: AM22)

Langwith Cave, Nether Langwith, Derbyshire [SK 517 695], References: Mullins (1913); Garrod (1926, 1927); Campbell (1977); Grigson (1978), Jenkinson (1984)

A cave site excavated by Mullins in 1903-12, Armstrong in 1924 and Garrod in 1927 The stratigraphical sequence incorporated four levels (Units 1 [deepest] to 4 [uppermost]). The finds from the above excavation sequences include LUP artefacts in association with both supposedly Late Devensian and Holocene faunal remains. The bulk of the faunal collection is conserved at the BMAG.

Horse remains were found in association with other Devensian mammals. The present author has studied all available horse remains from Langwith Cave (J.W. Jackson Collection) at the BMAG. Information with some specimens notes them as "L2A" and "L2B". Because Grigson (1978) notes that the faunal remains are not stratigraphically well-documented, it is unknown whether this indicates origination in Unit 2. The other Devensian mammals include lynx, hyaena, woolly rhinoceros, arctic fox, brown bear, and reindeer. Jenkinson (1984) believes that this assemblage represents a Late Devensian one. The present author is of the opinion that it is a mixed Middle to Late Devensian assemblage.

Pin Hole, Creswell, Derbyshire [SK 533 742], References: Mello (1875); Armstrong (1931); Jackson (1967); Campbell (1977); Jenkinson (1984); R. Jacobi (pers. comm.)

One of the Creswell Crags caves in the Peak District first excavated by Mello in 1874, by Armstrong in 1924-38, and most recently by Collcutt in 1974. Campbell (1977) notes that the stratigraphy at Pin Hole consists of LUP overlying EUP which overlies Middle Palaeolithic. Finds from the Armstrong excavations include Middle Palaeolithic, EUP and LUP artefacts as well as abundant Pleistocene mammalian remains. The collection is conserved at the MM, the NHM and CCVC. Radiocarbon dates (Appendix 1) on mammalian remains provide evidence for both a probable Mid-Late Devensian (c. 42,200-22,500 BP) and a Late Glacial (c. 14,000-11,000 BP) assemblage.

According to Jenkinson (1984), remains of horse are present in almost all stratigraphic levels including the Middle Palaeolithic, EUP, LUP and latest Upper Palaeolithic; however, the author has been unable to locate the relevant Late Glacial specimens, thus, these remain undetected in the assemblage (R. Jacobi, pers. comm). Furthermore, a recently obtained radiocarbon date (Appendix 1) for horse places it within the Middle Devensian or earlier (c. 44,900 BP or infinite), a result which

supports only pre-Late Glacial presence of horse at the site. The additional mammalian fauna from the Mid-Late Devensian assemblage includes reindeer, bison, giant deer, mammoth, hyaena, lion, and woolly rhinoceros; and the Late Devensian (Late Glacial) faunal assemblage includes reindeer, mammoth, arctic hare, and aurochs.

Region 8:

Pixie's Hole, Chudleigh, South Devon, References: Collcutt (1986)

A cave site first investigated by W. Buckland, T. Northmore and J. MacEnery in the 19th century and excavated further by Collcutt in 1976-79. Collcutt (1986) uncovered a stratigraphic sequence in which he identified an occupation area at the lowest level. Finds include "Creswellian" artefacts as well as mammalian remains. A Late Devensian date is suggested for this occupation level and radiocarbon dates on the fauna are awaited to confirm this (Collcutt, 1986). Unfortunately, these dates are not yet available.

Horse remains (teeth and bone) are present from Collcutt's excavation and the present author has studied these at the NHM. Associated mammalian fauna includes brown bear, bovid, hyaena, red fox, cf. red deer and wolf.

Torbryan 6 (Torbryan Caves), Torbryan, Devon [SX 815 675], References: Walker and Sutcliffe (1967); A. Roberts (pers. comm., 1992); Hedges *et al.* (1996: AM22)

The Torbryan Caves were excavated by J. Widger c. 1865-90; and specifically, Torbryan 6 (near Tornewton Cave) was excavated by both Widger during the late 19th century and more recently by the British Museum in 1991. Widger found LUP artefacts in the Torbryan Caves and a "Lower Palaeolithic handaxe" and Pleistocene fauna in Torbryan 6 (Campbell, 1977; A. Roberts, pers. comm). A stratigraphic sequence was identified by the BM team and includes a cave-earth horizon containing a hearth deposit, flint artefacts, and cut-marked/burnt mammalian remains The collection is conserved in BMFH Subsequent radiocarbon dates (Appendix 1) from this horizon support a Late Glacial age (c. 12,100 BP and c. 11,100 BP).

No Late Glacial horse remains were identified by the BM team; however, horse dating to the Middle Devensian is definitely present An existing radiocarbon date (c 32,000 BP. Appendix 1) for a horse tooth from a lower horizon in the sequence supports this (Hedges *et al.*, 1996: AM22). The Late Glacial cave-earth fauna includes reindeer and arctic hare.

Tornewton Cave (Torbryan Caves), Torbryan, Devon [SX 816 674], References: Sutcliffe and Zeuner (1962); Campbell (1977); A. Roberts (pers. comm.)

A cave site excavated by Sutcliffe in 1944-60 and subsequently by the British Museum in 1989-92. Finds from the Sutcliffe excavations include mammalian and human remains and possible LUP artefacts from the so-called 'Reindeer Stratum' which was thought to date to the Late Glacial. Investigation and re-examination of the stratigraphy of the cave by the BM team has cleared up some confusion regarding dating. The 'Reindeer Stratum' is now known to be Mid-Late Devensian in age and radiocarbon dates (c. 34,800-22,200 BP: Appendix 1) on mammalian remains support this (A. Roberts, pers. comm.). The faunal collections are conserved at the NHM and BMFH.

Horse remains are present from the 'Reindeer Stratum' and are thought to date to the Middle Devensian though no radiocarbon dates currently exist for horse. Associated mammalian remains from the 'Reindeer Stratum' include wolf, fox, hyaena, stoat, bear, woolly rhinoceros, reindeer, bovid, mole, and hare.

Region 9:

Badger Hole, Wookey Hole, Somerset [ST 532 479], References: Balch (1938-53); McBurney (1961); Campbell (1970, 1977)

One of the Wookey Hole cave sites, excavated by Balch in 1938-53, McBurney in 1958 and Campbell in 1968. Campbell (1977) notes that the "simplest" stratigraphic sequence incorporates Layers A-F (bedrock-surface). Late Pleistocene deposits were recorded by all excavators and finds include EUP and possible LUP artefacts as well mammalian remains. The collection is conserved at the WM. An early radiocarbon date (Appendix 1) on burnt bone fragments from Layer A2 suggests a pre-Late Glacial age for this deposit (> 18,000 BP) Subsequent radiometric determinations on human remains have produced Holocene dates (c. 9,400-9,100 BP and c. 1,400 BP: Appendix 1).

Horse remains from Badger Hole are present and the author has studied some of this material at the WM. Size variation was noticed which may indicate the presence of Middle Devensian and possibly Late Glacial horses. See chapter 5 for a full discussion of size variation through time. Campbell (1977) lists additional mammalian remains from EUP deposits as including bear (*Ursus* cf. *arctos*), woolly rhinoceros, hyaena,

Felis sp., giant deer, fox (*Vulpes/Alopex*), otter, mammoth, bison, arctic lemming, root vole, and possibly reindeer.

Brean Down Shelter, Brean, Somerset [ST 295 588], References: ApSimon *et al.* (1961); ApSimon (1977); Campbell (1977); Grigson (1978); Hedges *et al.* (1996: AM22); R. Jacobi and A. Currant (pers. comm.)

The site was excavated by ApSimon, Donovan and Taylor in 1954-60 and more recently re-explored by Jacobi and Currant in 1993-94. According to ApSimon (1977), the stratigraphical sequence represented Devensian deposits: Late Devensian (Layer 8B), Middle-Early Devensian (Layers 8C-12) and Early Devensian (Layer 13). Finds from the supposed Late Glacial deposit (Layer 11: lower 11A and upper 11B) include artefacts (Layer 11A, a sandy limestone breccia) as well as mammalian remains (Layers 11A and 11B) (Grigson,1978; Campbell, 1977). Jacobi and Currant's recent excavations have also yielded mammalian remains from aeolian sediments, but no artefacts. The collection is conserved at the UBSSM and the NHM. Radiocarbon dates were attempted on bone from Layer 11A which proved to have insufficient collagen, suggesting that the remains from this deposit are pre-Late Glacial in age (ApSimon, 1977). A recent radiometric determination has been more successful, and does indeed support the suggestion that the mammalian assemblage is older than Late Glacial (i.e. > 41,200 BP) (Appendix 1: Hedges *et al.*, 1996: AM22).

Horse remains are present in the Devensian faunal assemblage and the present author has studied a small sample of postcranial bones in the collection held at the NHM. The associated mammalian remains include wolf, bear, arctic fox, reindeer, bison, woolly rhinoceros, lemmings, steppe pika and possibly mammoth and giant deer.

Clevedon Cave (or Walton Bone Cave), Clevedon, Somerset [ST 418 726], References: Davies (1907); Reynolds (1907); Palmer and Hinton (1929); Gilbertson and Hawkins (1974); Campbell (1977)

A small cave site discovered in 1905 while quarrying for gravel, Clevedon Cave was excavated by Reynolds and Davies in 1906 and by Palmer and Hinton in 1927 Subsequently, the deposits were re-examined by Gilbertson and Hawkins in 1971. Reynolds (1907) obtained mammalian remains in the cave-earth on the cave floor and the mass deposits filling the cave. Palmer and Hinton (1929) revealed a stratigraphical

sequence with four levels of deposits. Most of the large animal remains were found in the lower levels of the lower gravel (Layer 4). Even though Reynolds (1907) notes Hinton as considering these deposits to be Middle Pleistocene in age, finds from the Palmer and Hinton excavation indicate possible Upper Palaeolithic human presence and include coal and one possible EUP artefact, a bone tool (Palmer and Hinton, 1929; Campbell, 1977). Moreover, Gilbertson and Hawkins (1974), upon re-examination (e.g. of molluscan evidence), conclude that the Pleistocene deposits from Clevedon amassed during the Devensian. A partial faunal collection is conserved at the BGSM, Keyworth; however, additional finds are thought to be held at Weston Super Mare Museum and Bristol City Museum.

Horse remains in large quantities were found by all excavators of the site and the present author has studied a small sample at the BGSM. Palmer and Hinton (1929) consider these remains from the gravels of Clevedon Cave to be contemporary with those from deposits at Erith and Crayford (Middle Pleistocene) "based on limb bone index comparisons". The remains of horse studied by the author at BGSM can be used to test (morphologically) Palmer and Hinton's theory that these horses were a "thick-limbed variety", pre-Late Glacial in age (see chapter 5). The age of these remains will be dealt with more fully later in section 4.5 in light of the identification by the author of a cutmarked horse tooth and a new radiocarbon dated horse bone (table 4.5) from the site which places the horse within the Middle Devensian (c. 28,900 BP). In addition to horse, associated mammalian remains include bear (*Ursus* sp.), wolf, foxes (*Vulpes/Alopex*), voles (*Microtus* spp.), rabbit and possibly lemming (*Lemmus* and/or *Dicrostonyx*). In the author's opinion, the collection from Clevedon Cave is in serious need of reassessment

Hyaena Den, Wookey Hole, Somerset [ST 532 479], References: Dawkins (1862, 1863, 1874); Balch (1914); Tratman *et al.* (1971), Tratman (1977b); Campbell (1977); Hedges *et al.* (1996 AM22)

A famous site excavated by Dawkins in 1859-74, by Balch in 1877-80 and most recently by Tratman in 1960-70 and Hawkes and Jacobi in the 1990's. Finds from both the Dawkins and the Balch excavations include Middle and EUP artefacts and Pleistocene mammalian remains The bulk of the faunal collection is conserved at the WM. According to Campbell (1977), the site was "only used briefly during the EUP" and much of the fauna dates to that period (i e. Middle Devensian); however, there is

evidence that a Late Glacial faunal assemblage does exist (Hedges *et al.*, 1996: AM22). Radiocarbon dates (Appendix 1) on mammalian remains support a Mid-Devensian age (c. > 40,400-24,600 BP) for the majority of the fauna and a Late Glacial age (c. 11,300 BP) for a small part of the fauna.

Horse remains are present and a dated horse tooth (Appendix 1) is within the Middle Devensian age range noted above. In addition to horse, the Middle Devensian faunal assemblage consists of red deer, reindeer, bear, wolf, and hyaena. The Late Glacial fauna, however, so far includes only red deer.

Whatley Quarry, Somerset, References: Donovan (1954); Currant (pers. comm.)

A natural fissure exposed through quarrying activities in 1951. The main cavity was encountered c. 20 feet below the surface of the ground, and on its floor, mammalian bones thought to be of Late Pleistocene age were dispersed in a "conical mass of partly compacted scree, formed of angular pieces of limestone and impure yellow clay" (Donovan, 1954). The collection is held at the UBSSM.

According to Donovan (1954) at least two individuals of horse are represented from the horse remains recovered (teeth: M16.2/29-35; postcranials: M16.2/27-28,36-39,42-50). Although this seems to be a substantial sample of horse material, the present author was unable to locate it in full, and only one bone (a "treated" radius: M16.2/27) was available for study at the UBSSM. The associated faunal remains are thought to include mammoth and glutton. Donovan (1954) notes that it is impossible to determine the contemporaneity of the animals based on preservation or stratigraphy. Additionally, A. Currant (pers. comm.) suggests that if the horse is truly associated with the glutton assemblage it may be of Devensian age. It seems that only a radiocarbon date can clarify the situation; however, due to the unknown preservative treatment of the bone a reliable determination may not be possible.

Fisherton, Wiltshire, References: Dawkins (1869); Harcourt (1971); Neil (1977)

A river deposit from which Pleistocene mammalian remains were recovered. Horse material is present and a small proportion of the assemblage was studied by the present author at the SSWM. Harcourt (1971) compared the size of the "Neolithic" horses from Durrington Walls, Wiltshire (see below for discussion) with the Fisherton ones which he assumed dated to the "Last Glaciation". For a more complete morphological comparison study see chapter 5. The fauna in addition to horse includes

red fox, lion (*Felis leo* var. *spelaea*), reindeer, roe deer, aurochs, bison, mammoth, pig, and woolly rhinoceros (Neil, 1977). This assemblage appears to be a mixed one.

Region 10:

Conningbrook Pit, Kennington, near Ashford, Kent, References: Hedges *et al.* (1989); Lister (1991); D. L. Harrison (pers. comm.)

A gravel pit investigated by Dr. D.L. Harrison and excavated by R. Knight *et al.* in the late 1980's. Finds include Devensian mammalian remains some of which have been radiocarbon dated (Appendix 1) and appear to be of Middle Devensian age (c. > 38,600-30,000 BP) (Hedges *et al.*, 1989; Lister, 1991; Harrison, pers. comm.).

Horse remains are abundant from Conningbrook Pit and the present author has studied a relevant sample at the HZM. In addition to horse the fauna includes bison, reindeer, red deer, wolf, hyaena, lion, red fox, arctic lemming, woolly rhinoceros, mammoth, and shrew (*Sorex* sp.).

Ightham Fissures (and Small Horse Fissure), near Borough Green, Kent, References: Jackson (1953)

The main site of Ightham Fissures is a Pleistocene fissure deposit with horse in addition to a mixed mammalian assemblage. The present author has studied much of the horse remains held at the NHM. The fauna includes red fox, steppe pika, small weasel, arctic hare, water vole, arctic fox, polecat, hyaena, reindeer, pygmy shrew, mole, Norway lemming, voles (*Microtus* spp.), roe deer, pig, sheep, badger, wildcat, mammoth, musk ox, woolly rhinoceros, wolf and red deer. Faunal remains from Ightham Fissures are also held at the BGSM, Keyworth. The above appears to represent a mixed Devensian to Holocene assemblage.

Furthermore, another deposit at Ightham Fissures is the 'Small Horse Fissure' which was probably excavated in 1898. The fauna consists of predominantly horse remains and the author has also had the opportunity to study this material at the NHM.

Region 13:

Coygan Cave, Laugharne, Dyfed, Wales [SN 284 091], References: Leach (1918); Grimes and Cowley (1935); Jackson (1953), Campbell (1977); Green and Walker (1991)

A cave site excavated by Allen and Hicks in 1866, by Laws in 1878, by W.F. Grimes in 1933 and by McBurney in 1963-64. Finds from the Allen and Hicks and the Laws excavations include possible EUP artefacts. The faunal assemblage from all excavations have been characterised as a "Last Glacial (Devensian) hyaena den fauna" (Green and Walker, 1991). The collection is conserved at the NMW, Cardiff and the Tenby Museum, Tenby. Subsequent radiocarbon dates (Appendix 1) seem to place this fauna in the Middle Devensian (c. > 38,700-24,600 BP).

Horse remains have been recorded from Coygan Cave in large quantities and the present author has studied a small sample in the NMW. Additional Late Pleistocene faunal remains are recorded as including wolf, arctic fox, red fox, brown bear, polecat, hyaena, mammoth, woolly rhinoceros, pig (*Sus sp.*), red deer, reindeer, giant deer and bison/aurochs from the 1963-64 excavations and possibly elk, lion, fallow deer and hippopotamus from the older excavations (e g. Laws in 1878) (Green and Walker, 1991).

Hoyle's Mouth Cave, Penally, Dyfed, Wales [SN 112 003], References: Dawkins (1874); Leach (1918); Garrod (1926); Savory (1973); Campbell (1977); Green and Walker (1991)

A cave site first formally excavated by Rev. G.N. Smith in 1862 and then subsequently by Rev. H.H. Winwood, Smith and Sandford in 1865, W. Boyd Dawkins in 1872, E.L. Jones in 1878-79 and Dr. H.N. Savory in 1968. More recently, excavations have been carried out by Dr. H.S. Green in 1986/1990. Finds from the above excavations include both Aurignacian and LUP artefacts and Late Pleistocene mammal remains from Layer 3A of the entrance chamber (Green and Walker, 1991). The faunal collection is conserved at the NMW, Cardiff. A radiocarbon date (Appendix 1) on animal bone from this layer gave a date of c 28,000 BP.

Horse remains are present from the above excavations and the author has studied a small proportion of cheek teeth from the 1968 and 1986/1990 excavations A radiocarbon date is awaited for one specimen of horse recently submitted by Green (pers. comm.) The Mid-Late Devensian mammalian faunal remains recorded for this

site include arctic hare, red fox, bear, reindeer and lemming from Layer 3A; bear, horse, deer and hyaena from a disturbed soil deposit; and an unstratified find of woolly rhinoceros (Green and Walker, 1991).

Priory Farm Cave, Monkton, nr. Pembroke, Dyfed, Wales [SM 9789 0184], References: Grimes (1933); Campbell (1977); Jacobi (1980); David (1991); Green and Walker (1991)

A cave site discovered and excavated by Dr. A. Hurrell Style and Mr. E. E. L. Dixon in 1906-07. Finds from a deposit (Layer 3) near the cave entrance include LUP artefacts which were not associated with any animal remains; however, in a different deposit (Layer 5) further within the cave, a Late Pleistocene mammal assemblage was recovered (Green and Walker, 1991). Also, an overlying layer (Layer 2) near the cave entrance was recorded as yielding bronzes, middens as well as mammal remains. The faunal collection is held at the NMW.

Horse remains were among the faunal finds from both older and younger deposits at Priory Farm Cave, and the present author has studied several postcranial horse bones from the collection at the NMW. Additional faunal remains from the older non-archaeological deposit (Layer 5) include bear, hyaena, wolf, reindeer, mammoth, and bovid (*Bison* sp./*Bos* sp.) According to Green and Walker (1991) gnawing on the bones indicates a hyaena den assemblage. Furthermore, remains from the younger deposit (Layer 2) include domestic ox and reindeer.

'Caldey Caves', Caldey Island, Dyfed, Wales [SS 14 97], References: David (1991); Green and Walker (1991)

Cave sites on Caldey Island with "unattributable faunal remains of probable Mid-Late Devensian type" (David, 1991). Horse remains are present in addition to wolf, cave bear, hyaena, lion, mammoth, ?woolly rhinoceros, red deer, elk, and ?bovid (*Bison* sp./*Bos* sp.). The collection is held at the NMW.

Potter's Cave, Caldey Island, Dyfed, Wales [SS 1458 9698], References: David (1991); Green and Walker (1991)

A cave site on Caldey Island occupied by humans during the Late Glacial period Finds include LUP artefacts and mammalian remains of Mid-Late Devensian type.

Horse remains are present in the assemblage as are hyaena, woolly rhinoceros, mammoth, and reindeer (Green and Walker, 1991). The collection is held at NMW.

Daylight Rock Shelter (Fissure), Caldey, Wales, References: David (1991)

A rock fissure with "unattributable faunal remains of probable Mid-Late Devensian type" (David, 1991). Horse remains are present in addition to bear, hyaena, lion, mammoth, woolly rhinoceros, giant deer, reindeer, and bovid (*Bison* sp./*Bos* sp.).

Leather's Hole, Gower, W. Glamorgan, Wales, References: David (1991)

A cave site with "unattributable faunal remains of probable Mid-Late Devensian type" (David, 1991). Horse remains are present in addition to hyaena, mammoth, and woolly rhinoceros.

Spritsail Tor, Gower, W. Glamorgan, Wales, References: David (1991)

A cave site with "unattributable faunal remains of probable Mid-Late Devensian type" (David, 1991). Horse remains are present in addition to red fox, bear, hyaena, mammoth, reindeer and bovid (*Bison* sp./*Bos* sp.).

Region 14:

Gop Cave, Clwyd, Wales, References: David (1991)

A cave site probably excavated in 1909. Horse remains are included in the Late Pleistocene mammalian assemblage and the present author has studied them at the NMW. David (1991) lists additional faunal remains of "probable Mid-Late Devensian type": hyaena, woolly rhinoceros, reindeer and bovid (*Bison* sp./*Bos* sp.). A further faunal collection from Gop Cave was encountered by the author at Manchester Museum, and it includes horse as well as human, badger, stoat, fox, and pig.

Plas Heaton, nr St. Asaph, Clwyd, Wales, References Dawkins (1871); David (1991), E. Walker (pers comm)

A cave site in north Wales with "unattributable faunal remains of probable Mid-Late Devensian type" (David, 1991). Although David (1991) does not include horse amongst this fauna, Dawkins (1871) does Horse is thought to be present in addition to hyaena, bear, wolf, reindeer, bison and glutton. Furthermore, remains of horse are held

in the collection at NMW; however, it is possible they could be modern rather than Late Pleistocene in age (E. Walker, pers. comm).

Pontnewydd Cave, Clywd, N. Wales [SJ 0153 7101], References. Green (1984); Green and Walker (1991); Hedges *et al.* (1996: AM22)

A cave site of great importance in the Elwy Valley, excavated by Green since 1978. Occupation of the cave is thought to have begun during the 'Lower Palaeolithic' (c. 230,000 BP) and finds include many Acheulian artefacts and some faunal remains (Green and Walker, 1991). Most recently, a faunal assemblage was discovered from the Upper Breccia debris flow of the new entrance, and radiometric dating supports a Middle Devensian age (c. 33,200-26,000 BP: Appendix 1). Horse remains are present and a dated horse tooth is within the Middle Devensian (c. 35,300 BP: Appendix 1). Associated faunal remains include bear, reindeer, ?wolf, arctic hare, red fox, cervid, and woolly rhinoceros (Hedges *et al.*, 1996: AM22).

Ogof Pant-y-Wennol, Gwynedd, Wales, References: David (1991)

A cave site with "unattributable faunal remains of probable Mid-Late Devensian type" (David, 1991). Horse remains are present in addition to hyaena, woolly rhinoceros and reindeer.

Sites with horse material: Late Glacial early Post Glacial

Region 1:

Bart's Shelter, Morecombe Bay, Cumbria, References T. Lord and R. Jacobi (pers. comm.)

According to T. Lord and R. Jacobi (pers comm), Bart's Shelter is a definite pre-Roman (probably Late Glacial) site located on the north shore of Morecombe Bay. Excavations have recently been undertaken by Mr. D. Stables; however, as of 1997 the stratigraphical and find information is unpublished. However, newly-obtained radiocarbon dates (S Stallibrass and P. Rowley-Conwy, pers. comm.) for the non-horse fauna range within the Late Glacial (c. 11,000-10,900 BP) as well as the Post Glacial (c. 4,500 BP) (Appendix 1) Sparse horse remains consisting of teeth and possibly bones are thought to have been found in association with elk and reindeer

material now dated to the Late Glacial (see above). Aurochs is to be included in the middle Post Glacial faunal assemblage.

Region 3:

Otley, nr. Leeds, W. Yorkshire, References: B Matthews (pers. comm.)

The open site at Otley lies alongside a former gravel quarry and excavations by B. Matthews have yielded many fossiliferous remains (some humanly worked) from terraces which are thought to date to the Late Glacial/early Holocene (i.e. c. 15,000 to 7,000 BP) according to pollen analysis. The majority of the finds are conserved at Otley Museum. According to B Matthews (pers. comm.), the stratigraphy is layered silt, peat and lacustrine clay over gravel deposits. The horse finds include a third phalange which is thought to date (by pollen analysis) to the Allerød interstadial of the Late Glacial; and a large tibia thought to date to c. 5,000 BP. Additional fauna from the site include: freshwater molluscs, reindeer, *Bos* sp. and human remains. Further dating evidence (by pollen analysis) suggests that two human skeletons are Neolithic (c. 5,000 BP) in age.

Dead Man's Cave (= "Anston Stones Cave"), N. Anston, S. Yorkshire [SK 529 834], References: Mellars (1969); White (1970); Campbell (1977); Jenkinson and Wynne-Griffiths (1986); Hedges *et al.* (1996: AM22); R. Jacobi (pers. comm.)

A cave site excavated by White, Mellars and Dolby on behalf of the Worksop Archaeological Research Group in 1967-68 A stratigraphic sequence was uncovered and subdivided into Sections and Units (levels) within them. According to Jenkinson and Wynne-Griffiths (1986), detailed information exists only for Section 1; however most of the stratigraphic levels contained faunal remains, some of which were associated with LUP artefacts. The faunal collection is conserved at the CCVC. Subsequent conventional radiocarbon dating of faunal remains (Appendix 1) from Sections 1 and 15 has yielded early Post Glacial dates (c. 9,900-9,800 BP); however, a recent accelerator determination (Appendix 1) on reindeer has yielded a slightly older date (c 10,000 BP), possibly indicating the terminal Late Glacial (Hedges *et al.*, 1996: AM22) The significance of this factor will be discussed further in section 4.5.2.

Horse remains are present from the site and the author has studied the available specimens (gnawed phalanx III. DMC-341, magnum carpal: DMC-251, cheek tooth: no number) at the CCVC. The above specimens are recorded as coming from Sections

(levels) 15 (3), 3(7) and 16(3), respectively. Two new radiocarbon dates (table 4.5) have been obtained in this study, and they now date the horse from Dead Man's Cave to the middle Late Glacial or Allerød (c. 11,800-11,600 BP) rather than the later Late Glacial/early Post Glacial. The probable Late Glacial/early Post Glacial mammalian faunal assemblage includes reindeer, brown bear, red fox, pig and bovid (*Bos* sp.). Other remains of unknown age (some unstratified) include sheep/goat, hare, rabbit, ?fallow deer, ox, badger, dog and cat (R. Jacobi, pers. comm.).

Stone Mill Shelter, nr. Maltby, S. Yorkshire [SK 5525 8973], References: R. Jacobi (pers. comm.)

A site with possible Late Glacial horse material (teeth) (R. Jacobi, pers. comm.).

Barry's Island, N. Yorkshire [TA 061 804], References: P. Rowley-Conwy and S. Stallibrass (pers. comm.)

A site with horse remains. One dated horse tooth (Appendix 1) dates to the Late Glacial (c. 10,160 BP). In addition, the faunal assemblage includes aurochs, red deer, roe deer and elk. Newly-obtained radiocarbon dates (S. Stallibrass and P. Rowley-Conwy, pers. comm.) on the non-horse fauna range within the Early to middle Post Glacial (c. 9,700 BP and c. 6,300-5,700 BP, respectively) (Appendix 1).

Flixton site II, Flixton, N. Yorkshire [TA 035 811], References: Fraser and King (1954); Moore (1954); Campbell (1977); P. Rowley-Conwy (pers. comm.); R. Jacobi (pers. comm.); R. Sabin (pers. comm.)

An open site of immense importance which lies on the northern edge of "Flixton Island" in close proximity to both the Seamer Carr and Star Carr sites. Flixton site II was originally excavated by Moore in 1948-51 and was most recently re-investigated by Schadla-Hall on behalf of the Vale of Pickering Research Trust in 1986. Moore determined a stratigraphical sequence which consisted of ten layers (Layers A-J. top to base). Layer E (peaty detritus mud) contained in its base Mesolithic artefacts, charcoals and animal remains, while a deeper deposit, Layer H (peaty nekron mud), yielded at its base a "well-defined level of horse bones" in association with LUP artefacts and a bird bone. Moore (1954) cites Walker and Goodwin's determination (based on pollen studies) that the horse horizon dates to Zone II (Allerød). However, Jacobi (1980) believes that the Layer H assemblage ("Bone Bed") dates within Zone III. The faunal

collection is conserved at the NHM and the SMR. One subsequent radiocarbon determination (Appendix 1) for organic mud overlying the "Bone Bed" assemblage yielded a Late Glacial (Zone III) date (c. 10,400 BP).

Two large collections of horse remains have been studied by the author at both the NHM and SMR. Unfortunately, all the remains held at the NHM have been heavily "treated" with PVA (polyvinyl acetate) (R. Sabin, pers. comm.). Moore (1954) notes that the remains, some of which were articulated when discovered, represent "at least three horses of moderate proportions". Also, he adds that the bones "show no trace of human interference" (i.e. humanly modified). However, the present study has revealed that both Moore's (1954) and Fraser and King's (1954) reports are incomplete because many Flixton site II horse specimens are not listed within these. Of course, this could be due to the fact that newly discovered remains could not be incorporated into the 1954 publication. The present author has determined that instead of three, at least six horses (i.e. six atlases and six axes: see fig. 4.3) are represented by the Flixton II remains. All of Fraser and King's (1954) identified elements (mainly postcranials such as first phalanges: see fig. 4.3) have been accounted for in the collections at the NHM and SMR as well as many other unpublished specimens. Unfortunately, the whereabouts of four lower cheek teeth (numbers WB27 and WB25) and possibly a few postcranials mentioned in Moore's (1954) publication are unknown. Furthermore, a few specimens (vertebral fragments) held at the NHM, particularly one partial thoracic vertebra (T16 according to R. Jacobi: reg. no. 1974.5004), have been newly-identified (R. Jacobi, pers. comm.; present author) as having cutmarks on their surfaces, thus disputing Moore's (1954) earlier assumption that no horse remains were humanly modified. Unfortunately, this specimen could not be radiocarbon dated due to its preservational state (i.e. heavy treatment with PVA). Despite the problems with the NHM material, the current author and P. Rowley-Conwy (pers. comm.) have recently obtained four radiocarbon determinations (table 4.5 and Appendix 1) for the Flixton site II horses from the SMR collection. These new determinations date the Flixton horses securely to the later Late Glacial/early Holocene or Younger Dryas/Pre-Boreal (c. 10,200-9,200 BP). The implications of these four new radiocarbon dates will be discussed later in this chapter (section 4.5 2). In addition to horse, the mammalian fauna from Flixton site II includes aurochs, red deer, ?elk, roe deer, pine marten, beaver, and pig

Fig. 4.3. Horse remains from Flixton site II, North Yorkshire (held at Scarborough Museum). Top: one of six axis vertebrae from the site (no. 1891.51.2); bottom: two first phalanges (left: no. 160E; right: no. 1890.51.2), both newly radiocarbon dated (see table 4.5).

Moughton Fell Cave, near Settle, Ribblesdale, N. Yorkshire [(SD 80 49)], References: Handby (1899); Jackson (1931)

A site in the Yorkshire Dales, near to both Sewell's Cave and Victoria Cave, which was investigated by J. W. Handby in the late 19th century. Finds include Late Pleistocene mammalian remains which are currently conserved in the MM.

Horse remains (one complete MTIII, no.7) are present and have been studied in detail in the current study. Jackson (1931) refers to this horse as the "*Equus robustus* type of Ewart", probably based on its robust morphology rather than its affinity with the horses of Solutré (i.e. Ewart's so-called Forest type) (see chapter 2). A new radiocarbon date (table 4.5) for this bone has placed it within the Late Glacial (c. 11,000 BP) Additional mammalian remains include brown bear, northern lynx, red fox, and arctic hare.

Seamer Carr, near Seamer, N. Yorkshire [(NGR: see below)], References: Schadla-Hall (1987, 1988, 1989); Clutton-Brock and Burleigh (1991)

An open site in the Vale of Pickering within close proximity to both Star Carr and Flixton Site II which was excavated by Schadla-Hall in 1977-86. The area was originally investigated in the mid-1970's by Cloutman and Chambers who discovered Zone IV/V deposits; however, excavations took place in earnest during the late 1970's. From 1977 onwards (for 6 years), Schadla-Hall undertook investigations at Site C (TA 036 820) which yielded evidence (e.g. animal remains-some humanly modified- and artefacts) of Mesolithic (Early and Late), Neolithic and Early Bronze Age occupations. In 1983-84, deposits at Site K (TA 034 820) (to the west of Site C) were found to consist of a Late Glacial occupation horizon (peaty) underneath an early Holocene one (peat-sealed), the two horizons separated by a sandy layer. Finds from these excavations included faunal remains (some humanly modified) as well as LUP and Early Mesolithic artefacts. Also in 1983, small areas to the south-west of Site C, Sites U and M, were investigated and the Site U deposits yielded faunal remains thought to date to the Early Mesolithic (Schadla-Hall, 1987, 1989). Furthermore, in 1984 an area just to the north of Site K, Sites L1 and L2, was also investigated and the deposits from Site L1 yielded LUP artefacts in the lower (peaty) horizon and Early Mesolithic artefacts as well as animal remains in the peat-sealed upper horizon The faunal collection is held at the NHM. Subsequent radiocarbon determinations on both environmental and faunal remains from Sites C, K and L1 have produced dates which

support the existence of both Late Glacial (c. 11,300-10,200 BP: Schadla-Hall, 1987) and early Holocene (i e. Early Mesolithic) (c. 9,900-8,700 BP: Appendix 1) deposits at those sites.

Horse remains are present from Sites C, K and L1 and the author has studied them in detail at the NHM. Unfortunately, due to their preservation within peaty deposits the majority of specimens are in poor condition and have had to be heavily treated with PVA. The horse collection consists mainly of cheek teeth and cranial elements; however, some postcranials (e.g. phalanges) are available. Schadla-Hall (1989) notes that many of the cheek teeth from Site C were stratified within the Late Glacial horizon (i e. below the Mesolithic level). Interestingly, Site L1 (Mesolithic horizon) yielded the most important find of horse, an almost complete mandible with cheek teeth intact (Clutton-Brock and Burleigh, 1991). Most importantly, this specimen (ARC 84.5103, Find No. 11933/4) has produced the only radiocarbon date (Appendix 1) for horse from Seamer Carr and it lies within the early Holocene range mentioned above. In addition to horse, the mammalian fauna from Seamer Carr (all sites) includes domestic dog, fox, aurochs, wild pig, roe deer, and red deer.

Sewell's Cave, near Settle, N. Yorkshire [SD 785 666], References: Raistrick (1936); T. Lord and R. Jacobi (pers. comm.)

A cave site situated two miles southwest of Moughton Fell Cave in the Yorkshire Dales which was excavated in 1934 (T. Lord, pers. comm.). Late Pleistocene mammalian remains were recovered from "glacial sediments", underneath Neolithic and Roman deposits. Newly-obtained radiocarbon dates (S. Stallibrass and P. Rowley-Conwy, pers. comm.) for some of the non-horse fauna range within the Late Glacial (c 10,800-10,700 BP) (Appendix 1)

Horse remains in small quantities are present from Sewell's Cave. The author has studied three specimens (a partial MTIII, a partial tibia and a cheek tooth) in detail and has also noted T. Lord and R. Jacobi's (pers. comm.) assessment that two specimens (MTIII/tibia) are of similar preservation (i e. rusty yellow with black specks), while the cheek tooth appears differently preserved. For the current study, a MTIII fragment was radiometrically dated (table 4 5) and produced a Late Glacial date (c. 10,700 BP). The associated mammalian remains include reindeer, bear and aurochs.

Victoria Cave, near Settle, N. Yorkshire [SD 839 650], References: Tiddeman (1872, 1875); Dawkins (1874); Garrod (1926); Jackson (1953); Campbell (1977); T. Lord (pers. comm.)

A famous cave site near to both Sewell's Cave and Moughton Fell Cave which was excavated by Dawkins and Tiddeman for the Settle Cave Exploration Committee in 1870-78 and Simpson in 1931/32. A stratigraphic sequence was uncovered which consisted of Pleistocene deposits underneath late Holocene (Romano-British) layers. The sequence within the Pleistocene deposits included three beds: the Upper Cave Earth (entrance breccia), the Laminated Clay, and the Lower Cave Earth (Tiddeman, 1875). Both the Upper and Lower Cave Earths yielded animal and human remains. Finds from the above excavations include LUP artefacts, three of which were made from reindeer and possibly red deer antlers. Subsequently, these three artefacts in addition to reindeer remains from the lower entrance breccia have been radiocarbon dated (Appendix 1) and lie within the Late Glacial age range (c. 11,800-10,200 BP). The faunal collection is conserved at the NHM under the (private) curatorship of Mr. T. Lord.

Horse remains are present from both Late Pleistocene and younger levels and the present author has studied all the available horse specimens (postcranials and cheek teeth) at the NHM. The majority of horse remains were derived from the entrance breccia of the Upper Cave Earth level. One radiocarbon date (table 4.5) for a cutmarked horse bone from the base of this level has been obtained for the current project; however, it dates to the late Holocene (c. 1,700 BP) and not the Late Glacial as expected by its provenance. For a fuller discussion of this discrepancy and others like it, see below (section 4.5.2). In addition to horse, faunal remains from the Upper Cave Earth (entrance breccia) include human, hare, fox, brown bear, reindeer, red deer and aurochs (T. Lord, pers. comm.). Although this list appears to be a 'typical' Late Glacial assemblage, T. Lord (pers. comm.) does note the presence of some "unambiguous Holocene faunal remains" (e g. domestic cattle) in this deposit. Furthermore, in addition to horse, the mammalian remains from the Romano-British levels are thought to include "Celtic shorthorn" (*Bos taurus*), goat, pig, and roe deer (Tiddeman, 1875).

Region 4:

King Arthur's Cave, Whitchurch, Hereford and Worcester [SO 547 157], References: Symonds (1871); Hewer (1926); Taylor (1928); ApSimon (1955); Lister and Scott (pers. comm.); N. Barton (pers. comm.)

A cave site located in the Wye Valley excavated by Rev. W. S. Symonds in 1871, by Hewer and Taylor in 1925-27, by ApSimon in 1955, and most recently by Barton in the 1990s. A supposedly secure stratigraphical sequence was distinguished by the early excavators and consisted of deposits in the "Passage"(Upper and Lower Cave Earths) and the "entrance Platform", and range in age from the Early-Middle Devensian through to the Post Glacial. According to Taylor (1928), the platform consists of six discrete Late Pleistocene/Holocene layers (top to base): Humus (later Post Glacial), 1st Hearth (early Post Glacial), Yellow Rubble [Upper and Lower Halves] (Late Glacial), 2nd Hearth (Late Glacial), Mammoth Layer (Middle Devensian), and Red Clay/Yellow Clay/Red Silt (Early-Middle Devensian). Finds from the Hewer and Taylor excavations include Late Pleistocene/Holocene mammalian remains as well as EUP and LUP artefacts. The bulk of the faunal collection is conserved at the UBSSM; however, small collections from the late 19th century excavations are held at the NHM (1870/71: 'Howard Collection'), Hereford City Museum and Art Gallery (1871: Symonds collection), and the Cheltenham Art Gallery and Museum ('Cornford Collection'). Attempts had been made to date the assemblages from each level by faunal and archaeological analyses (see approximate ages above in parentheses), but these techniques proved imprecise (A. Lister and K. Scott, pers. comm.). Subsequent direct radiocarbon dating of the fauna from the Platform layers has helped clear up the existing problems to some extent. The radiocarbon dates (Appendix 1) obtained by A. Lister and K. Scott lie within the Middle Devensian (c. >39,500-34,900 BP) for fauna from the Red Clay and Mammoth layers, and the Late Glacial (c 12,200-12,100 BP) for fauna from the 2nd Hearth and Yellow Rubble (Lower Half) layers.

Horse remains are present in all layers (the "Platform" and the "Passage") except possibly the recent Humus of the "Platform", and the present author has principally studied the available specimens (all numbered W2.20 or W2.21) from the Late Glacial/early Post Glacial layers (i e. the upper Platform layers) in detail at the UBSSM Mainly cheek teeth and incisors are in these layers; however, a meagre sample of postcranial elements (e g. Phal. II, MCIII) is also present. Also, the current

author has identified possible cutmarks on horse bone and teeth from the Yellow Rubble and 2nd Hearth, layers which also yielded LUP artefactual evidence. However, some identifications are not secure and according to R. Jacobi and J. Cook (pers. comm.), one in particular (a 2nd Hearth tooth with marks: W2.21/524) is ambiguous. The provenance of all the horse specimens was checked against the "slip catalogue" held at UBSSM in order to confirm that each is well-stratified. Four new radiocarbon dates (table 4.5) have now been obtained for the horses from each of the four Late Glacial/early Post Glacial layers (2nd Hearth, Lower/Upper Yellow Rubble and 1st Hearth). They agree well with the previous dates; however, it was unexpected for all dates to lie solely within a Late Glacial range (c. 13,300-12,000 BP). The implications of these determinations will be discussed in section 4.5.2. The following is a list of the associated mammalian fauna from each layer which includes horse (Taylor, 1928; A. Lister and K. Scott, pers. comm.): 1) First Hearth: red deer, roe deer, sheep, aurochs, bovid (*Bos* sp.), pig, bear (*Ursus* sp.), reindeer, and hyaena; 2) Yellow Rubble: red deer, reindeer, pig, fox, arctic or collared lemming, voles (*Microtus* spp.), steppe pika and arctic hare; 3) Second Hearth: red deer, arctic hare, and bovid (*Bos* sp.); 4) Mammoth Layer: hyaena, bear (*Ursus* sp.), mammoth, woolly rhinoceros, red deer, arctic hare, and large bovid (*Bos/Bison*); 5) Red Clay/Yellow Clay/Red Silt: hyaena, bear (*Ursus* sp.), red deer, reindeer, and large bovid (*Bos/Bison*); 6) Upper Cave Earth: hyaena, bear (*Ursus* sp.), mammoth, woolly rhinoceros, red deer, reindeer, bovid (*Bos/Bison*), sheep, and hare (*Lepus* sp.); 7) Lower Cave Earth: hyaena, bear (*Ursus* sp.), woolly rhinoceros, red deer, reindeer, large bovid (*Bos/Bison*) and fox. Furthermore, it must be noted that some mixing (older and younger deposits) is evident within the above faunal assemblages for each layer.

Ossom's Cave, Grindon, Manifold Valley, Staffordshire [SK 095 557], References: Bramwell (1954, 1955); Campbell (1977); Scott (1986); Bramwell *et al.*. (1987)

A cave site in the Peak District excavated by Bramwell on behalf of the Peakland Archaeological Society in 1954-56. A stratigraphic sequence was uncovered and distinct horizons (Layers A-E) were recognised. Two horizons (Layers C and D) yielded Late Pleistocene mammalian remains; however, Layer C ("breccia of loose sharply angular limestone fragments") was of particular interest because of the abundant Late Glacial faunal remains (especially reindeer) and LUP artefacts which were found (Scott, 1986). The faunal collection is conserved in the SOTMAG.

Subsequent radiocarbon dates (Appendix 1) on the faunal remains from Layer C support a Late Glacial age range for the assemblage (c. 12,200-10,600 BP). However, see below for some indication of contamination (i.e. Post Glacial elements) within the Layer C deposit. Furthermore, a radiocarbon determination was obtained for faunal remains from Layer D and dates to the Middle Devensian (c. 25,600 BP).

Horse remains are present from both Layer C and Layer A (Post Glacial deposits), and the author has studied four specimens in detail at the SOTMAG. Two incisors (O.IV/V.C 12 and O.VIII.3) were from Layer C and one incisor (O.IV A) and one MCII (O.VIII-IX.1) were from Layer A For the current project, one incisor from Layer C was radiocarbon dated and its date (table 4.5) lies within the Late Glacial range mentioned above (c. 10,900 BP). For a further discussion of the implications of this dating on previous determinations for the site, see below (section 4.5.2). Associated mammalian fauna within the Layer C deposit includes reindeer, arctic hare, pigmy and common shrews, bank, water, field/common and northern voles, arctic and Norway lemmings, an unidentified bovid (*Bos/Bison*) and human remains (Bramwell *et al.*, 1987). Subsequently, however, both the human and the bovid remains were found to date to the Holocene (c. 4,900 BP and c. 2,000 BP, respectively) (Appendix 1). Mammalian remains from Layer A (Post Glacial deposits) include, in addition to horse, red fox, badger, dog, cat, pig, sheep, cattle, red deer, water vole, mole and hare (*Lepus* sp.). Also, even though no horse is present in the deposit, the mammalian remains from Layer D (Mid-Late Devensian) include red fox, red deer, bovid (*Bos/Bison*), arctic lemming and water, field/common, and northern voles.

Thor's Fissure Cave, Wetton, Staffordshire [SK 099 550], References: Wilson (1937); Jackson (1962); Campbell (1977); Neil (1977); Grigson (1978); Burleigh *et al.* (1983)

A cave site in the Manifold Valley excavated by Wilson and Bramwell in 1927-35. Finds include LUP (possibly Layer SB) artefacts (Campbell, 1977) as well as possible Late Glacial faunal remains The faunal collection is conserved at the BMAG. A radiocarbon date (Appendix 1) for the site lies within the Late Devensian (c. 20,400 BP).

One horse bone (partial pelvis or innominate bone) was examined by the author at the BMAG. The Late Glacial fauna is thought to include reindeer (Grigson, 1978). In addition, Neil (1977) notes that the cave deposits yielded red deer and giant deer (Layer B 2).

Condover (Norton Farm Pit), Shropshire, References: Coope and Lister (1987); Lister (1991); A. Lister (pers. comm.)

The site at Condover is a kettle-hole at Norton Farm Pit. Four mammoth skeletons were discovered there during excavations of the site in 1986; and subsequent radiocarbon dating (Appendix 1) of these finds securely establish them as part of a Late Glacial assemblage (c. 12,700-12,300 BP). The partial tibia of a horse was also discovered during these excavations; however, it is not known whether it is part of the Late Glacial assemblage or a later, Holocene one (A. Lister, pers. comm.)[2].

Region 5:

Dog Hole Fissure, Creswell Crags, Derbyshire [SK 535 742], References: Jenkinson *et al.* (1982); Jenkinson (1984); R. Jacobi (pers. comm.)

A "fissure fill" site in the Creswell Crags gorge excavated by Jenkinson in 1977-78. A stratigraphic sequence (Layers 6-2 [spits 1-16]: shallowest to deepest) was established and abundant mammalian remains were recovered. The collection is held at the CCVC. Jenkinson (1984) considers the faunal assemblage to be Post Glacial and a subsequent bulked radiocarbon date (Appendix 1) for faunal remains from spits 8-16 is consistent with this, yielding an latest Late Glacial/early Post Glacial date (c. 10,000 BP).

Horse remains are present from Dog Hole and the author has studied only one specimen (an incisor: DH 514/1) which was recorded as having come from spit 7 (Layer 3b) (R. Jacobi, pers. comm.). It proved impossible to trace the whereabouts of the two fragments of horse from spit 3 (Layer 4) which Jenkinson (1984) includes in his faunal list. For the current study, the horse incisor (DH 514/1) was radiocarbon dated and yielded a late Holocene date (c. 1,700 BP) (table 4.5). Additionally, the faunal assemblage is thought to include wolf, red deer, wild boar, red fox, beaver, giant deer, domestic cow, hare (*Lepus* sp.), bank vole and shrew (*Sorex* sp) (Jenkinson, 1984).

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[2] A recently obtained radiocarbon determination (OxA-9041) for the Condover horse tibia securely dates it to the later Post Glacial (259 ±35 BP)

Calling Low Dale Rock Shelter, off Lathkill Dale, Derbyshire, References: Bramwell (1973)

A rock shelter site located in the Peak District said to have yielded "patinated blades in association with horse and red deer in a deep stratum" of supposed Mesolithic age (Bramwell, 1973).

Fox Hole Cave, Earl Sterndale, Derbyshire [SK 100 662], References: Bramwell (1963, 1969, 1971); Campbell (1977)

A cave site located on High Wheeldon Hill first investigated by the Peakland Archaeological Society in the late 1920's and excavated in earnest by Bramwell in 1961-76. Earlier investigations focused on the Bear Chamber, while serious excavations focused on the Main Passage (including the Entrance and First Chambers). During excavations from 1961 onwards, a stratigraphic sequence within the Main Passage was established and consists of Layers F-A (base-top: Late Pleistocene to Roman). Layers E to D are the Late Pleistocene/early Holocene layers, while Layers C to A are considered the middle and later Holocene layers. Bramwell (1971) notes that the cave was probably occupied several times during its history; however, evidence of an occupation by people of the LUP or Mesolithic culture (i.e. Late Glacial or early Post Glacial) is almost certain and comes from Layer D. Finds from this layer, subdivided into D2 and D1 (lower and upper, respectively: both sandy clay deposits), include mammalian remains as well as LUP and Mesolithic artefacts, two of which were made from reindeer and red deer antlers. These finds are possibly associated with a burial of a brown bear skull which was discovered in the First Chamber of the Main Passage (Bramwell, 1971; Campbell, 1977). Also, Bramwell (1971) notes that, in Layer D, the flint artefacts were found in association with "a little charcoal and split bones of horse and red deer". The bulk of the faunal collection is conserved at the BMAG. Subsequent radiocarbon dating (Appendix 1) of two antler artefacts (from the First and Bear Chambers) supports a Late Glacial occupation of the cave (c. 12,000 BP).

Horse remains are present from Fox Hole Cave and the author has studied all the available material in detail at the BMAG. This material consists of cheek teeth and cranial/postcranial elements from the excavations in 1929, 1961-63, 1965-66, 1972, and 1974-75 Bramwell (1971) has identified horse from Layer D, and the specimens from the 1972-75 excavations (seen in the current study) certainly came mainly from

Layer D (First Chamber). However, the present author has recently re-identified a cervical vertebra (originally identified as brown bear) as horse, which possibly comes from the "Neolithic" Layer C (lower level: "C2 sec 2B"). Also, it seems evident that some of the horse specimens (e.g. one astragalus, one calcaneum, one Phal. II, cheek tooth rows) cited by Neil (1977) and Bramwell (1969) are not in the collections at Buxton. There is evidence (i e. notes in the collection) of the possibility that two of these specimens are on loan to Stockport Museum. As part of the current study, four new radiocarbon determinations (table 4.5) have been obtained for four separate horse specimens (three recorded as coming from Layer D) and they now securely date the Fox Hole horses to the Late Glacial (c. 12,000-10,800 BP). The associated faunal remains from Layer D are thought to include reindeer, hare (*Lepus* sp.), voles (*Microtus* sp.), aurochs, brown bear, red deer, wolf, fox, pine marten, pig and badger (probably recent). Furthermore, even though Bramwell (1971) records no horse from this layer, it is necessary to list the additional fauna from C2: brown bear, wolf, cat, badger, fox, wood mouse and bank vole (Bramwell, 1971). However, because Bramwell (1963) notes evidence of badger burrowing between Layers C and D, the mixing of their deposits and finds cannot be ruled out.

Mother Grundy's Parlour, Creswell Crags, Derbyshire [SK 536 743], References: Armstrong (1925); Garrod (1926); Campbell (1969, 1977); R. Jacobi (pers. comm.)

A cave site situated in the Creswell Crags gorge, excavated by Armstrong in 1924, McBurney in 1959-60 and by Campbell in 1969. Several different stratigraphical sequences have been established consisting of at least five distinct layers: Armstrong's stratigraphy for excavations of the north-western corner of the entrance platform consists of spits within Layers 1-5 (base-top); McBurney's stratigraphy for excavations of the north-eastern side of the entrance platform consists of Layers A-F (base-top); and Campbell's stratigraphy for excavations of "probably undisturbed deposits between the areas dug by Armstrong and McBurney", like McBurney's, consists of Layers A-F (base-top) (Campbell, 1977). For the purposes of the current project, work focused on McBurney's and Campbell's Late Pleistocene/early Holocene Layers LB, SB, C and possibly D, however, Armstrong's "hearth" and "cave earth" levels (i e Layers 2 and 3) are also of some importance The above excavations yielded abundant Pleistocene/Holocene mammalian remains, some of which are charred and/or associated with artefacts. The archaeological finds from the Armstrong (base spit to

various levels of the middle spit), McBurney (Layers B to C), and Campbell (Layers LB and SB to D) excavations include LUP (two of which are made from reindeer antler), LUP/Mesolithic, and Mesolithic artefacts (Campbell, 1977). The faunal collection is conserved at the MM (Armstrong collection), NHM (Armstrong collection), CCVC (Campbell collection), and CUMAA (McBurney collection). Subsequent radiocarbon dating (Appendix 1) of both environmental and faunal samples from Mother Grundy's Parlour (from the "hearth" and Layers SB, B, interface B/C, and C) has provided Late Glacial (c. 12,200-11,100 BP), early Post Glacial (c. 9,900-6,800 BP) and even later Post Glacial dates (c. 4,100-3,700 BP).

Horse remains are present in all three collections from Mother Grundy's Parlour and the author has studied both the Armstrong and McBurney specimens in detail. Campbell (1977) notes that Armstrong (1925) recorded horse in all of his excavated levels; however, based on his own investigations, Campbell (1977) believes that the main horse assemblage is most likely confined to the lower, Late Glacial levels, even though horse remains were found in the upper, early Post Glacial levels. These horse assemblages consist mainly of cheek teeth (some with cutmarks); however, a few postcranial elements (e.g. metapodial, astragalus) are available. Before the current project started, all the specimens in the Armstrong collection at the NHM were unwashed and unidentified. The present author has now washed and identified all the cheek teeth and postcranial elements in this collection and given them provisional numbers for identification purposes. Furthermore, the author has identified for the first time, cutmarks on the buccal surface of one upper cheek tooth (now dated. see Appendix 1) from the Armstrong collection. Radiocarbon dating of horse remains (from Layer SB and Layer C) from these collections has previously been undertaken by R. Jacobi and all four resulting dates lie within the Late Glacial (c. 12,500-12,300 BP: Appendix 1). Unfortunately, one specimen from Layer B failed to produce a date (R. Jacobi, pers. comm.). For the current radiocarbon project, two specimens (from the "hearth" and Layer C) and were chosen for dating, and these again date the horse to the Late Glacial (c. 12,000-11,900 BP: see table 4.5). For an in-depth discussion of the implications of these dates see section 4.5 2 The associated Late Glacial/early Post Glacial faunal assemblage is thought to include brown bear, wolf, aurochs, giant deer, red deer, common shrew, tundra vole and possibly reindeer. Additional mammalian remains from various levels include hyaena, lion, mammoth, woolly rhinoceros, bovid (*Bos* sp /*Bison* sp.) and pig.

Robin Hood's Cave, Creswell, Derbyshire [SK 534 742], References: Mello (1875, 1877); Dawkins (1876, 1877); Garrod (1926); Campbell (1969, 1977); Charles and Jacobi (1994)

One of the Creswell Crags caves in the Peak District, first excavated by Dawkins and Mello in 1874-76 and then by Campbell in 1969. Four chambers, three of which are termed 'Western', 'Eastern' and 'Central', are evident within the cave. It seems that only Campbell (1969, 1977) has provided a reliable stratigraphic sequence which consists of multiple Layers A-F (from base to top). Some layers have been subdivided further by Campbell, but the Late Pleistocene Layers A, LSB, OB, and USB (= Middle Palaeolithic to LUP/Mesolithic) are the focus of the current study. Finds from the all excavations include abundant mammalian remains (Layers A, B/A, LSB, OB, and USB: a sequence consisting of red sand, cave earth and breccia) as well as EUP (Layer B/A), LUP (Layer B/A, LSB, OB) and LUP/Mesolithic (Layer USB) artefacts. Interestingly, one artefact is a large mammal rib fragment incised with the head and "forequarters" of a horse from Dawkins and Mello's Layer B2 ("cave earth") (i.e. possibly Campbell's Layer B/A) (Campbell, 1977). This artefact is a unique find of Upper Palaeolithic art depicting a horse in the British Isles; however, in continental Europe finds such as this are ubiquitous (see chapter 2). According to Charles and Jacobi (1994), there are two preservation types (i.e. indicative of older and younger assemblages) evident for the faunal remains from these layers: 1) older = stained, worn and fragmented, and 2) younger = yellow/white with well-preserved anatomical detail. The faunal collection is conserved in the MM, CCVC, NHM, and BGSM. Several radiocarbon dates (Appendix 1) had been attempted previously on the faunal remains from the layers mentioned above and a range within the Middle Devensian and Late Glacial has been obtained (c. > 42,900-28,500 BP and c. 12,600-12,300 BP).

Both Campbell (1977) and Charles and Jacobi (1994) list horse among the faunal remains in Layers and Layer interfaces USB OB, OB, OB/LSB, LSB, LSB/A, and A. The present author has studied a small proportion of these remains (teeth and postcranials) from the Campbell collection at the CCVC for the purpose of choosing new specimens for the current radiocarbon dating project. The two new dates complement those which were done previously on horse (c. 10,600 BP and c. 10,400 BP: Appendix 1), however, it must be noted that the new ones lie within two different periods of the Late Glacial (c. 12,200 BP and c. 10,500 BP: table 4.5). Moreover, these

dates for Layer OB horses are considered more reliable than the previous Layer OB date, due to the nature of that bone sample (i e. horse bulked with cervid). According to Charles and Jacobi (1994), the large mammal fauna can be separated into two groups based on the preservation types given above. In addition to horse, the faunal assemblage of type 2) includes arctic hare, fox (*Vulpes* sp.), reindeer, pig, sheep/goat, and possibly red deer. On the other hand, the fauna of type 1) preservation (i e. pre-Late Glacial) are thought to include only hyaena, woolly rhinoceros and possibly brown bear. Additionally, the mammalian fauna (some of known age: see Appendix 1) mentioned by other authors (e.g. Campbell, 1977) includes voles (*Microtus* spp. and *A. terrestris*), arctic or collared lemming, Norway lemming, wood mouse, steppe pika, arctic fox, pine marten, human, wolf, mammoth, giant deer and bovid (cf. *Bovini*); however, the existence of some of these species (e.g. arctic fox, pine marten) is debatable (Charles and Jacobi, 1994).

Stoney Low, nr. Sheldon, Derbyshire [SK 174 674], References: Radley (1968); Bramwell (1968, 1973, 1977); R. Jacobi (pers. comm.)

An open site on Sheldon Moor excavated by Bramwell, Goodwin and Radley in the 1960s. An Upper Palaeolithic deposit was discovered sealed beneath a Neolithic assemblage (Radley, 1968). The excavation yielded possible LUP/Mesolithic artefacts as well as two groups of mammalian remains (see below). A proportion of the faunal collection is thought to be conserved at Sheffield Museum (R. Jacobi, pers. comm.).

Horse remains (one eroded cheek tooth) were recovered from the excavation. In addition to horse, the mammalian remains consisted of red deer, hare (*Lepus* sp), domestic pig and ox. According to Bramwell (1968), the red deer and hare are associated with the horse as part of the Upper Palaeolithic occupation and the pig and ox are part of the Neolithic assemblage

Region 6:

Uxbridge (Three Ways Wharf), Colne Valley, Middlesex [TQ 0525 8458], References: Lewis (1991); J. Rackham (pers comm)

An open site near the River Colne excavated by the Museum of London in 1986-1988 During excavations, a stratigraphic sequence was determined consisting of multiple layers. Overlying the basal fluvial deposits, the discovery was made of an "undisturbed sequence of sediments" from which LUP/Mesolithic artefacts associated

with Late Glacial/early Post Glacial faunal remains (Scatters A, B and C) were recovered (Lewis, 1991). The faunal collection, which contains some humanly modified specimens, is held at the MOL. Two occupation phases have been identified: Scatter 'A' dating to the Late Glacial and Scatter 'C' dating to the early Post Glacial, together yielded the majority of finds. Subsequent radiocarbon dating (Appendix 1) of faunal (horse only) samples from Scatter 'A' supports a later Late Glacial date (c. 10,300-10,000 BP) for the assemblage. Also, there is one thermoluminescence date for an artefact from Scatter 'C' which supports an early Post Glacial date (c. 8,000 BP: Lewis, 1991) for the assemblage. Further radiocarbon dates for the faunal assemblages from both scatters are now awaited.

Horse remains are present from both Scatters 'A' and 'C'. The collection is very fragmentary and consists of both cranial and postcranial elements; however, the author has located and studied only a small proportion of this collection (all cranial) at the MOL. Unfortunately, some of the faunal material was under further study (J. Rackham, pers. comm.), and therefore unavailable to the author for investigation. Two previous radiocarbon dates on horse (Scatter 'A') have yielded the later Late Glacial dates mentioned above. The Scatter 'A' horse is associated with reindeer and possibly "pig", while the Scatter 'C' associated fauna includes a mixed assemblage of reindeer, red deer, roe deer, ?"pig", beaver, red fox and wolf. It is not known whether the "pig" in each case is wild boar or domestic pig.

Rikof's Pit, Broxbourne, Hertfordshire [TL 377 072], References. Warren *et al.* (1934); Campbell (1977); Jacobi (1980)

An open site located in the Lea Valley from which finds were first collected by the pit foreman c. 1938. At this site, Holocene alluvium deposits (possibly dating to the 'Boreal' Mesolithic) of the River Lea were discovered underlying Holocene peat deposits and overlying Late Pleistocene arctic deposits (the Arctic-bed) Finds from the alluvium and arctic deposits include mammalian faunal remains as well as a possible Upper Palaeolithic artefact (from the Deposit D: calcareous nekron mud) (Jacobi, 1980). The faunal collection is held at the NHM. Interestingly, Warren *et al.* (1934) also note finds of a Mesolithic industry in "leached sand below peat" at Broxbourne

Horse remains are present from the Holocene alluvium at Rikof's Pit and the author has briefly studied the available specimens (mainly metapodials) at the NHM. All the horse specimens from these deposits have a distinctive preservational state (i e.

a dark brown/black, perhaps peat-stained colour). In addition to horse, the faunal assemblage from the Holocene alluvium includes cervid (antlers) as well as bovid (*Bos* sp.) (horn cores). On the other hand, the arctic-bed fauna includes woolly rhinoceros, mammoth, lemmings, and reindeer.

Region 7:

Sproughton (Site 1), near Ipswich, Suffolk [TM 133 443], References: Wymer *et al.* (1975); Wymer (1975, 1976); Rose (1976); Campbell (1977)

An open-air site (Site 1) excavated by Saunders and Wymer and the Suffolk Archaeology Unit (SAU) in 1972-4. Sand and gravel deposits (a buried channel of the River Gipping) were exposed during work at Devil's Wood Pit (Sproughton); and during excavations, a stratigraphical sequence was determined which consists of six "deposits". According to Wymer *et al.* (1975), the sand and gravel deposit dates to the Late Devensian through to the early Holocene. Finds from Site 1 include mammalian remains and LUP/Mesolithic artefacts (e.g. uniserial barbed projectile points made of bone and antler, a long blade industry) possibly from the pollen Zone II-IV horizon within the sand and gravel deposit. The faunal collection is conserved at the IM/SAU. Subsequent radiocarbon dating (Appendix 1) of environmental and 'faunal' (i.e. modified bone and antler) remains from different levels within the archaeologically rich deposit has yielded dates which range within the Late Glacial/ early Post Glacial period (c. 12,000-9,900 BP).

Horse remains are present from Sproughton (Site 1), and the author has studied all the available material at the IM. According to Wymer *et al.* (1975), "a skull and articulated cervical vertebrae of a horse were discovered from a sand bed about 1-2m deeper and 15-20m distant from where the barbed point no.2 was found" (artefact dated to c. 10,700 BP: see Appendix 1). These, however, are not the only horse remains from Sproughton because the author has studied several other specimens (postcranial elements), some of which were found in 1974 during excavations by the Suffolk Archaeology Unit. The provenance of some of these specimens is noted as "c. 12 feet down in peat" However, it has proved impossible to determine whether 1) all of the horse specimens have the same provenance, and 2) the complete collection of horse elements (possibly all belonging to one individual, a female) was discovered at the same time or at different times during the two years of excavation (i e. 1972-74). Despite these problems, one radiocarbon date (table 4.5) was obtained for a horse

humerus as part of the current project. This dates the horse from Sproughton to the later Late Glacial (c. 10,300 BP). In addition to horse, the faunal remains found within these Late Glacial/early Holocene deposits include elk and reindeer. Furthermore, R. Markham (pers. comm.), formerly of the Ipswich Museum, has mentioned that the reindeer remains appear to have a different preservation (a grey colour) to those of horse. Also, interestingly, Wymer (1976) notes finds of elk in "a dump of dark grey sand at the same level, nearer the river". Due to time constraints, however, comparisons of horse, elk and reindeer preservation could not be undertaken during the present study.

Region 8:

Kent's Cavern, Torquay, Devon [SX 934 641], References: Pengelly (1865-80); Campbell and Sampson (1971); Campbell (1977); R. Jacobi (pers. comm.)

A cave site excavated by MacEnery in 1825-29, Pengelly in 1865-80 and Ogilvie in 1926-40. Accurate recording of the stratigraphy and provenance of many of the remains is given in W. Pengelly's diaries. Within this multi-level sequence is the Late Glacial 'Black Band' level, so-called because of the presence of LUP hearths (wood charcoal and burnt bones) in the upper part (Layer B2) of the cave earth deposits in the 'Vestibule'. Finds from the above excavations include abundant mammalian remains (some with human modification) as well as EUP (Layer A2) and LUP (Layer B2 or 'Black Band') artefacts. The bulk of the faunal collection is held at the NHM and Torquay Museum. Extensive radiocarbon dating of mammalian remains from both Late Glacial and older levels (e g. cave earth Layer A2, the Vestibule, Great Chamber and Gallery) has provided determinations (Appendix 1) which support a Late Glacial age (c. 14,300-11,800 BP) for the mammals from the 'Black Band' as well as Middle Devensian age (c. 34,600-23,100 BP) for mammals from Layer A2 and the Vestibule.

Horse remains are present from various levels at Kent's Cavern and the author has studied these in detail. The focus was on 'Black Band' specimens (identified by Pengelly's black numbers on each specimen), however, a small proportion of Middle Devensian remains were investigated for comparison. Pengelly's (1865-1868) counts of horse include 17 teeth found in the Vestibule ('Black Band' within Layer B2· LUP) However, the present author has only been able to locate (with the help of R. Jacobi) 10 teeth (some with cutmarks) from the Vestibule as well as one other 'Black Band' tooth from the 'North-East Gallery'. Other important remains (now dated to the Late

Glacial: see below) include a cut-marked partial MCIII from the 'Black Band' and a maxillary ramus with cheek teeth (one with definite cutmarks identified by the author: M.566/1864) from the 1st level of the cave earth underlying the 'Black Band'. Previous radiocarbon dating[3] on horse remains fall into two periods: the Late Glacial (c. 12,300 BP: Appendix 1) and the Middle Devensian (c. > 38,300 BP). A new date for horse (the maxilla mentioned above), obtained as part of the current project, again indicates a Late Glacial age (c. 12,300 BP) (table 4.5). For implications of these dates see below (section 4.5.2). Associated mammalian remains from the 'Black Band' include giant deer, brown bear, aurochs, reindeer, steppe pika, vole (*Arvicola* sp.), and fox (*Vulpes* sp.). Fauna (in addition to horse) from older deposits include lion, wolf, mammoth, hyaena, woolly rhinoceros, bovid (*Bos/Bison*), bears (*Ursus* spp.), red deer, reindeer, fox (*Vulpes/Alopex*?), and giant deer.

Neale's Cave, Paignton, Devon [(SX 88 60)], References: Jackson (1962); Jenkinson (1983)

A cave site near Paignton Zoo excavated by Neale and Sutcliffe in the 1950's. The deposits yielded abundant vertebrate mammalian remains and Neale and Sutcliffe (Jackson, 1962) originally assumed this faunal assemblage to date to the Mesolithic.

Horse remains (two specimens) are present within this assemblage and the author has studied them in detail at the NHM. The two specimens collected by Sutcliffe in 1958/59 are: a partial MCIII from Area IX Layer 3: M.22093, and an ?associated MCII from Area XI Layer 3: M.22094. Both had received some sort of bone pre-treatment. Despite this potential problem, the MCIII was radiocarbon dated for the current project, and it yielded a secure later Late Glacial or Younger Dryas date (c. 10,400 BP) (table 4.5). The associated Late Glacial/early Post Glacial faunal assemblage includes reindeer, red fox, hare (*Lepus* sp.), wolf/dog (*Canis* sp.), red deer, cattle (*Bos* sp.), lynx, badger, and mole.

Three Holes Cave, Torbryan, Devon [SX 814 675], References: Rosenfeld (1964); Campbell (1977); Hedges *et al.* (1996: AM22); A. Roberts (pers. comm.)

A cave site excavated by Widger in 1880, by A. Rosenfeld in 1955-61 and most recently by the British Museum (BM) in 1989-92. Finds from the Rosenfeld

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[3] Two radiocarbon dates on horse material (cut cheek teeth) have recently been obtained by R. Jacobi (pers. comm.) and both lie within the Late Glacial: OxA-8002, 12,240 ±100 BP; OxA-8003, 11,800 ±180 BP.

excavations include LUP artefacts and animal remains from the so-called 'Black Band' or Late Glacial hearth deposit. The most recent excavations of Three Holes Cave by the BM team have revealed a secure stratigraphic sequence through Upper Palaeolithic, Mesolithic and Neolithic horizons. The collection is conserved in the BMFH. Located in a cave-earth deposit underneath the Mesolithic horizon was an LUP horizon of two levels. The lower level finds consisted of 'Creswellian' artefacts associated with cut-marked animal bones while finds from the upper level of the LUP horizon included "Final Palaeolithic" (or *Federmesser*) artefacts and fragmented animal bones. Radiocarbon dating securely places the animal remains (both the 50's and 90's excavations) from the 'Black Band' and LUP horizons within the Late Glacial (c. 12,400-10,000 BP) (Appendix 1). Finds from the BM's Mesolithic horizon include later Mesolithic (c. 8,000 BP) artefacts and burnt and/or decorated animal bone. Finds from the BM's Neolithic horizon include pottery, artefacts and burnt animal bones. Radiocarbon dates (c. 6,300- 4,600 BP) for remains from these two archaeological deposits can be seen in Appendix 1.

Horse remains were identified in both Rosenfeld's and the BM's excavations. The present author has studied in detail the cheek teeth and a few postcranial elements, the majority of which come from the lower level of the LUP horizon associated with the 'Creswellian' industry. A few specimens are either unstratified or of unusual preservation and may either be part of the Late Glacial assemblage or a later (e.g. Bronze Age or Romano-British) one. Also, unfortunately, the author was unable to trace the whereabouts of some Late Glacial specimens, thus they were not available for study. Radiocarbon dating (Hedges *et al.*, 1996: AM22 and Appendix 1) confirms a Late Glacial age (c. 12,200-12,000 BP) for the well-stratified horse remains from Three Holes Cave. Associated mammalian fauna from the LUP horizon includes arctic hare, brown bear, and red deer while the fauna from the later horizons includes red deer, roe deer, wild pig and aurochs. In addition, an interesting find of a "warm climate indicator species", the pond tortoise (*Emys orbicularis*) dated to the Neolithic (c. 4,600 BP) must be mentioned (Hedges *et al.*, 1996: AM22).

Region 9:

Aveline's Hole, Burrington Combe, Somerset [ST 476 587], References: Davies (1921,1922, 1923, 1925); Garrod (1926); Savage (1969); Campbell (1977), Tratman (1977a, 1977b); Jacobi (1987)

Aveline's Hole is a cave site in the Mendips which was discovered in 1797. Although early attempts were made to excavate the site, excavations were undertaken in earnest by Davies of the University of Bristol Spelaeological Society (UBSS) from 1919-1933, during which time a sound stratigraphical section was revealed (Davies, 1921,1922; Garrod, 1926). The main bone-bearing layer, the "red cave-earth", contained flint implements and both human and faunal remains thought to date to the latest Pleistocene (i.e. the Late Glacial or Late Upper Palaeolithic). After excavation and study, the finds were stored in the UBSS Museum, Bristol; however, due to extensive bombing of the city during the Second World War, much of the material and archives were destroyed. The remaining meagre collection from Aveline's Hole is currently housed in the UBSSM, Bristol. Subsequent radiocarbon dating (Appendix 1) of some remaining human and non-horse animal bones indicates that two distinct periods are represented: one Late Glacial (c. 12,500-12,100 BP) and the other early Holocene (c. 9,700-8,100 BP). Jacobi (1987) distinguishes these two intervals as "periods of use": the Late Glacial occupation as a "task site" for the processing of animal carcasses and the early Holocene one as a human "burial site".

Garrod (1926) notes horse amongst the faunal remains found in the cave-earth layer. One notable horse find, discovered in 1924, was a horse tooth decorated with incisions. However, due to wartime action, the horse material currently available consists of a single horse first phalanx (Phal I: M1.2/3) which the present author has been able to study in detail. A newly obtained radiocarbon date (table 4.5) for this bone lies within the later Late Glacial (c. 10,200 BP). In addition to horse, the associated mammalian faunal remains present in the cave-earth layer consist of brown bear, lynx, reindeer, red deer, arctic or varying hare, Norway and arctic (or collared) lemmings, and steppe pika. Tratman (1977b) regards these remains as being representative of two faunas one cold and the other temperate. Furthermore, Savage (1969) suggests that "at least two faunas, if not three" are represented at Aveline's Hole: a Late Pleistocene or early Holocene cold fauna, an intermediate fauna without domestic species and a possible later fauna with domestic species See chapter 3 (section 3.4) for comments regarding fauna in relation to climate and chronology

Bridged Pot Shelter, Ebbor Gorge, Somerset [ST 529 488], References: Balch (1928); Jackson (1953); McBurney (1959); Campbell (1977)

Bridged Pot Shelter is a small rock shelter located near the famous Late Pleistocene site of Wookey Hole, Ebbor Gorge. H.E. Balch discovered and carried out preliminary excavations on the site in 1926-27, uncovering Late Pleistocene and middle Holocene (i.e. Neolithic or Early Bronze Age) cave-earth deposits which contained both fauna and artefacts. These remains were subsequently deposited in the WM and can be found there today. In 1958, C.B.M. McBurney re-investigated the site and carried out further excavations. Six deposits (Layers A-F) were uncovered during that year, Layer B providing abundant fossiliferous remains and evidence of human activity (e.g. burnt bone, charcoal, a possible LUP artefact) which dates to the Late Glacial/Upper Palaeolithic. The McBurney material is now conserved at the CUMAA. An earlier radiocarbon date (Appendix 1) of c. 9,100 BP for an animal bone from Layer B appears to postdate the Late Glacial fauna.

It seems evident that of the two main excavations at Bridged Pot, only Balch (1928) found horse remains in the cave-earth deposit noted above. McBurney (1959) makes no note of having discovered horse remains in Layer B. The horse finds coming from Balch's Late Pleistocene deposit are probably associated with the so-called "tufa level" and consist of a partial tibia, a shaft fragment and a distal sesamoid bone. The sesamoid bone (or navicular) was discovered by the present author in a bag of unwashed reindeer bone fragments (all "tufa level") at the WM. As well as being a new identification of horse for the site, this bone has also provided a new Late Glacial radiocarbon date for the current project (c. 10,800 BP) (table 4.5). Furthermore, a combined list of the associated mammalian assemblage of Late Glacial aspect from Bridged Pot includes. reindeer, red deer, brown bear, Norway and arctic lemmings, steppe pika, and voles (*Microtus* sp., *Arvicola* sp.).

Chelm's Combe Shelter, Cheddar, Somerset [ST 463 545], References: Clay (1927); Balch and Palmer (1927), Jackson (1927); Campbell (1977); Currant (1991)

A 'rockshelter' site excavated by Balch in 1925/6 from which a sequence of Holocene deposits overlaying a Late Pleistocene one (limestone screes) was determined. Excavation was carried out by way of "horizontal spits, numbered downwards (1-22)" which "did not necessarily coincide with natural layers" (Currant,

1991). Finds from the Late Pleistocene deposit include faunal remains. Campbell (1977) notes two possible LUP artefacts (both from spit 9), a drilled bird bone and a notched mammal bone, as having been associated with the split long bones of horse and reindeer; however, Balch and Palmer (1927) disputed that these are humanly modified specimens. The faunal collection is conserved at Wells Museum, but a small part is currently on loan to the Natural History Museum. Several radiocarbon dates (Appendix 1) are available for the Pleistocene fauna of Chelm's Combe and range within the later Late Glacial (c. 10,900-10,100 BP).

Horse remains are present from the site and the author has studied all available specimens in detail. Jackson (1927) lists horse remains (some of which he distinguishes as the *robustus*-type of Ewart: see chapter 2) as having come from spits ("Layers") 7-13; however, the present author was only able to locate nine specimens from spits 7, 9 and 12. Three specimens (metacarpal, fragmentary lower jaw with 6 teeth, and forepart of the lower jaw with incisors) mentioned by Jackson (1927) as having come from "Layer" 10, seem to be missing from the present collection. Despite this apparent problem, radiocarbon determinations have been made on two specimens of horse. The first date (Appendix 1) was obtained as part of the previous dating project mentioned above and the second one (table 4.5) is newly obtained for the current project. Both (c. 10,400 BP and c. 10,700 BP, respectively) lie within the range mentioned. The associated mammalian remains include reindeer, red deer, arctic hare, arctic fox, bear (*Ursus* sp.), wolf, red fox, stoat, ?glutton, ?wild boar, pika, arctic lemming, voles (*Microtus* spp./*Arvicola* sp.), wood mouse, mole, and pigmy shrew.

Gough's (New) Cave, Cheddar, Somerset [ST 467 539], References: Garrod (1926); Parry (1929, 1931); Donovan (1955); Tratman (1960), Hawkes *et al.* (1970); Tratman *et al.* (1972); Campbell (1977); Jacobi (1985); Currant (1986, 1991); Currant *et al.* (1989), Burleigh *et al.* (1991)

An immensely important site within a large cave system situated near the lower end of Cheddar Gorge which was first investigated by Sollas in the 1880's and Gough in 1892-1903. However, it was excavated in earnest by Parry in 1927-31, by Painter in 1948-53, by the Tratman on behalf of the UBSS in 1957-59 and most recently by Currant, Jacobi and Stringer in 1986-87/1989-90 Serious attention was drawn to Gough's (New) Cave in 1903 when the so-called 'Cheddar Man' (now dated to the Mesolithic: see below) was discovered in the 'skeleton pit' or 'Cheddar Man Fissure'.

Later, Parry established a stratigraphical sequence within the entrance/vestibule area of the cave and excavated the deposits in six inch (15 cm) spits (1-24: top to base). Also, Painter's excavations yielded finds whose provenance he correlated with that of Parry's. Currant (1986), however, observes that Parry's excavation spits "did not coincide" with the bedding of the cave deposits. During the most recent excavations (1986-87), previously unexplored deposits of upper fine gravel and underlying red silt within the cave, near the 'Cheddar Man fissure', were examined (Currant *et al.*, 1989). Finds from both older and recent excavations include abundant Late Pleistocene mammalian remains (many humanly modified) as well as LUP artefacts (stone, bone and antler), three of which are bâtons-de-commandement. These finds were mainly associated with the cave earth and breccia deposits (spits 6-16); however, some remains were found within the underlying, supposedly older Pleistocene deposits (spits 17-25) (Currant, 1986; Burleigh *et al.*, 1991). Also, it must be mentioned that although spits 1-5 contained the bulk of the 'Post Pleistocene' mammalian assemblage, some supposedly Holocene remains (e.g. pig and roe deer) found their way into the Late Glacial deposits (spits 12 and 14, respectively). Unfortunately, some of the remains from the older excavations were supposedly 'thrown out' or 'given away', and their whereabouts are now unknown (Currant, 1986). Despite this, the surviving faunal collections (one of the largest for the British Late Glacial) are conserved at the NHM (Parry, Painter and 1986-87/1989-90 collections), UBSSM (1957-1959 collection), Cheddar Caves Museum (Painter collection), WM and Somerset County Museum, Taunton. Furthermore, it is important to note that Gough's (New) Cave must not be confused with the nearby site of Gough's (Old) Cave, the old show cave, which also yielded Upper Palaeolithic and Holocene finds, but to a much lesser degree. Subsequent radiocarbon dating of animal remains from Gough's (Old and New) Cave have yielded dates (Appendix 1), the majority of which lie within a Late Glacial/early Holocene range (c. 12,800-9,100 BP). However, some dates (Appendix 1) lie within the middle to late Holocene (c. 2,900-1,700 BP).

Abundant horse remains are present from all excavations of Gough's (Old and New) Cave and the author has studied all collections in detail except for that conserved at Taunton. Parry's collection is by far the largest, horse remains having been originally recorded from almost all levels (i e spits 5-6, 8-24 and 'Cheddar Man Fissure'). However, Currant (1986) notes that horse remains are no longer traceable from spits 6, 21-23 as well as those from the 'Cheddar Man Fissure' deposits Despite

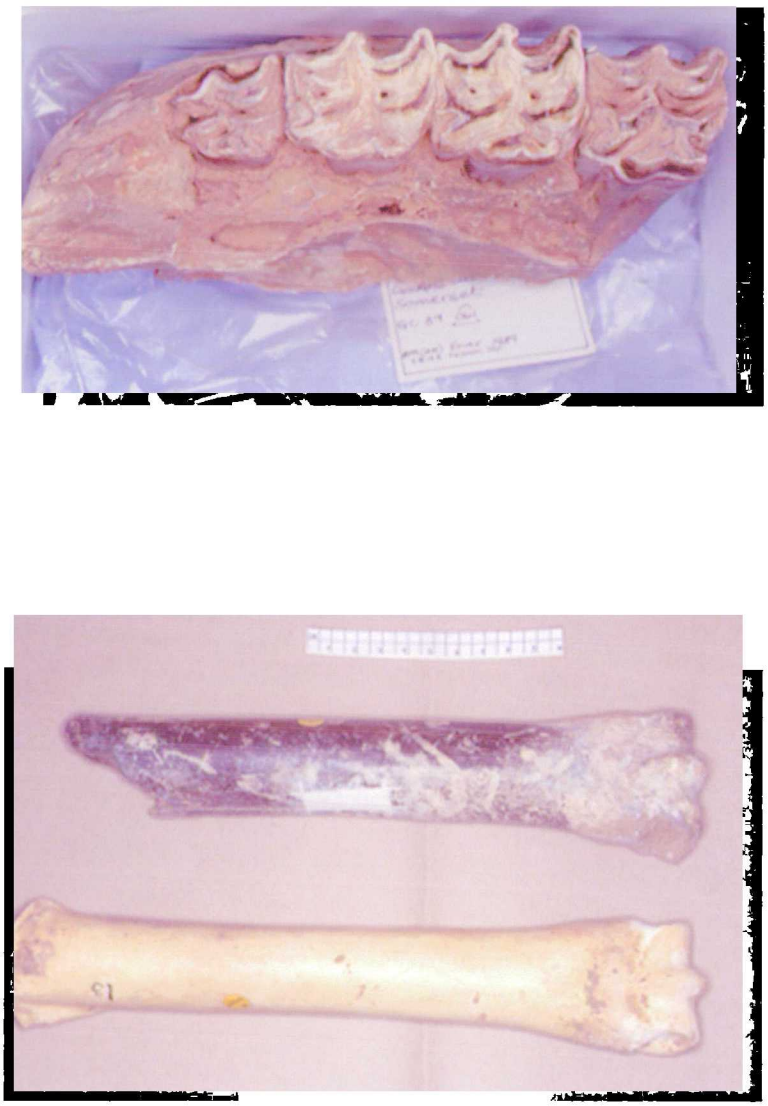

Fig. 4.4. Horse specimens from Gough's (New) Cave, Somerset (held at The Natural History Museum). Top: partial maxilla with right P4-M3 intact (GC'89, no. 061); bottom: two third metatarsals, the complete specimen being from a subadult individual (top: no. M49805; bottom: no. M49873).

these problems, all parts of the skeleton are represented (i e. teeth, cranial and postcranial elements. see fig 4.4) in the surviving collections, and many specimens retain the cutmarks associated with butchery by humans. The previous radiocarbon dating mentioned above includes several specimens of horse which all date to the Late Glacial (c. 12,900-12,200 BP) (Appendix 1). However, as expected by its provenance, a newly dated (table 4.5) horse specimen (a small, cutmarked astragalus) from spit 5 dates to the later Holocene (c. 1,200 BP). The implications of all the Gough's horse dates will be discussed later in this chapter (section 4.5.2). The associated Late Glacial mammalian faunal assemblage from all excavations includes: human, arctic hare, steppe pika, beaver, arctic or collared lemming, Norway lemming, water vole, northern vole, tundra vole, wolf, arctic fox, red fox, brown bear, lynx, mammoth, red deer, reindeer, aurochs and saiga antelope. Also, in addition to horse, the mammalian fauna from the post-Pleistocene layers (4, 5, 6) and other deposits (i.e. intrusive) includes pig, polecat, sheep/goat, roe deer and bovid.

Sun Hole, Cheddar, Somerset [ST 467 541], References: Tratman and Henderson (1928); Tratman (1955); Campbell (1970, 1977); Collcutt *et al.* (1981); Hedges *et al.* (1996: AM22)

A small fissure cave situated in Cheddar Gorge excavated by Tratman in 1927-28 and 1951-53, by Campbell in 1968 and most recently by the UBSS in 1977-80. A stratigraphic sequence was determined and consists of units (I-III) subdivided into layers (1-35) (Collcutt *et al.*, 1981). Finds from both the excavations include LUP artefacts and Late Devensian faunal remains from Unit I (Layers 1-13), a deposit composed of fine sand and silt together with coarse limestone. The faunal collection is conserved at the UBSSM and WM and some remains (1950's excavations) are thought to have been 'treated' (Hedges *et al.*, 1996 AM22). Despite this problem, subsequent radiocarbon dates on faunal remains have yielded Late Glacial dates (Appendix 1) in the range c. 12,400-10,100 BP

Horse remains are present from Sun Hole and the author has examined all available specimens (cranial [M5 2/24], postcranials [M5 2/14 2 and /67] and cheek teeth [M5.2/13 0-13 4, /14 0 and /30]) from Unit I at the WM Radiocarbon dates (Appendix 1) for horse remains support a later Late Glacial date (c. 10,500-10,300 BP) for the Sun Hole horses; however, one recent date (Appendix 1) on a cutmarked cheek tooth dates to earlier in the Late Glacial (c. 11,500 BP) See below (section 4.5 2) for a

full discussion of the implications and significance of these determinations. Associated faunal remains from Unit I include human, mole, wolf, red fox, brown bear, weasel, wild cat, reindeer, beaver, wood mouse, arctic or collared lemming, Norway lemming, bank vole, water vole, narrow-skulled vole, northern vole, steppe pika, and arctic hare (Collcutt *et al.*, 1981). In addition, a recent record of saiga antelope complements this interesting Late Glacial mammalian assemblage.

Wolf's Den, Wavering Down, near Loxton, Somerset, References: Beevers (1948); Jackson (1953); A. Currant and R. Jacobi (pers. comm.)

A cave site and supposed wolf's den first investigated in 1944 (Jackson, 1953). Finds include Late Pleistocene mammalian remains which are conserved at the WM.

Horse remains (associated limb bones) are present and the author has studied them in detail as part of the current study. A new radiocarbon date (table 4.5) on a horse bone has yielded a Late Glacial date (c. 10,100 BP). Associated Late Glacial fauna includes brown bear, red deer, wolf, fox, hare, ?rabbit, pika and "arctic vole" (*Microtus* sp.). A. Currant and R. Jacobi (pers. comm.) consider this assemblage to be a small one which took a short period to accumulate, and may also include saiga antelope as part of the fauna.

Avington VI, nr. Newbury, Berkshire, References: Barton and Froom (1986); Lewis (1991); R. Jacobi (pers comm)

An open site excavated by R. Froom which yielded a 'Long Blade' industry (Barton and Froom, 1986). Avington VI supposedly dates to the Late Glacial based on environmental and stratigraphic evidence (Lewis, 1991; R. Jacobi, pers. comm.). Even though Barton and Froom (1986) note no fauna at the site, R. Jacobi (pers. comm.) suggests that the faunal assemblage may have included horse remains (fragments of teeth) which were subsequently sent to the RMAG for identification by H.H. Carter. However, upon visiting the RMAG, the present author could not locate the horse finds, thus a thorough study could not be undertaken.

Thatcham (Sites I and II), Kennet Valley, Berkshire [SU 506 668], References: Wymer (1962); Churchill (1962); Carter (1975-76); Neil (1977), Grigson (1978)

Open sites (Sites I-V) in the Kennet Valley excavated by Wymer on behalf of the Reading and Newbury Museums in 1958-61. A Maglemosian flint industry was

discovered at the sites as well as abundant early Holocene faunal remains. According to Wymer (1962) the stratigraphy of Sites I and II consisted of a layer of black peat or marl overlying a supposedly undisturbed "ancient surface" (the occupation level) which yielded flint artefacts (some Mesolithic) and mammalian remains. The bulk of the faunal collection is held at the NHM; however, some untreated material is held at the RMAG. Early dating of the sites by both tool and pollen analyses, supported a theory of initial occupation during the Pre-Boreal (Zone IV) and lasting through to the Boreal (Zone VIa) or Atlantic (Zone VIIa) periods. Subsequent radiocarbon dates (Appendix 1) on environmental samples (i.e. wood and charcoal) and mammalian remains from Sites II, III, IV and V date to the latest Late Glacial/early Holocene and range c. 10,400-9,400 BP. Only one date (Appendix 1) for a rabbit (*O. cuniculus*) from Site V has indicated evidence of late Holocene or Recent (c. 270 BP) intrusions. The majority of faunal dates lie within the early Holocene (c. 9,800-9,400 BP). Grigson (1978) likens Site I to Site V and dates it along with Site II to the Early Mesolithic (Pre-Boreal/Boreal).

Horse remains are present from Sites I and II at Thatcham and the author has studied the three specimens (2 cheek teeth and 1 canine: ARC 1970.3013) at the NHM. All three seem to have similar preservation. Grigson (1978) notes that the Site I horse specimens are well-stratified in Mesolithic deposits while the Site II specimen has doubtful stratigraphy. This, however, contradicts another view that the Site I canine is "definitely Mesolithic" while the Site I upper cheek tooth is "probably intrusive" (Neil, 1977). This highlights the possibly uncertain stratigraphy associated with the horse teeth. To complicate matters further, Campbell (1977) notes Wymer's opinion that the teeth may instead have come from the underlying river gravels (i.e. they may be Late Glacial or older). In view of these potential chronological and stratigraphical problems, the present author proceeded with the radiocarbon dating of one tooth (Site I) for the current project and obtained an unexpected Recent date (c. 290 BP) (table 4.5). The implication of this new date in relation to previous dating and stratigraphy will be discussed below (section 4.5.2) The combined list of mammalian remains from all sites includes red deer, roe deer, elk, wolf, pig, beaver, pine marten, badger, red fox, hare, wild cat, dog and aurochs.

Wawcott (Sites XII and XXIII), near Kintbury, Berkshire [SU 408/410 675/674], References: Froom (1972); Carter (1975-6); Grigson (1978); J. Cook (pers. comm.)

A series of floodplain sites (Sites IV, XII, XV, XXIII, XXVI and XXX) in the Kennet Valley excavated by Froom in the 1970's which yielded Mesolithic artefacts and mammalian remains. The partial faunal collection is held at the RMAG. Grigson (1978) notes that Froom (1972) identified horse remains from two sites: Site XII, believed to be early Holocene on the basis of a Mesolithic industry (i.e. long blades); and Site XXIII, dated to pollen Zone VIIa, with a Late Mesolithic industry, and charcoal from the site which yielded a radiocarbon date of c. 6,100 BP (Appendix 1). Apparently, Site XII is very disturbed and the identification of horse is doubtful; however, there is a good identification of horse for Site XXIII (Froom, 1972; Grigson, 1978).

Although Froom (1972) notes the presence of horse remains from Sites XII and XXIII (cheek tooth fragments and a vertebra, respectively), the author could neither locate them nor identify any additional specimens at the RMAG, where the faunal collection from Wawcott was examined in full. It is possible that some of the collection is held privately, and thus unavailable for study (J. Cook, pers. comm.). The associated fauna from both Sites XII and XXIII includes aurochs. Additional associated fauna from Site XXIII includes red deer.

Hengistbury Head (Sites A,B,C,C1,C2), Bournemouth, Dorset [SZ 179 906, (SZ 178 906), (SZ 178 904)], References: Mace (1959); Campbell (1977); Smith (1992)

All open-air sites: material was collected from Site A by Druitt in 1913, from Site C by Draper in 1957, Cotton in 1963 and Ridley in 1969. Site B was excavated by Calkin c. 1953, Site C1 by Mace in 1957 and Site C2 by Campbell in 1968-69. Finds from all investigations and excavations include LUP, Mesolithic and later artefacts.

According to Campbell (1977), "numerous" horse remains were thought to have been discovered during previous excavations; however, they are of unknown age and their "whereabouts are unknown". If horse remains did exist then they could have been either Late Glacial or Post Glacial in age.

Region 10:

Darent River Gravels, Sevenoaks Reserve, Kent [TQ 525 575], References: Harrison *et al.* (1981); D. L. Harrison (pers. comm)

An open site at Redlands Pit situated in the Darent River Valley and investigated by J. and D. L. Harrison since 1975. The river gravel (i.e. fluviatile) deposit has yielded abundant remains of Late Pleistocene/early Holocene and later Holocene mammals (Sites I and II) as well as possible Neolithic and Bronze Age artefacts. The bulk of the faunal collection is conserved at the HZM. Due to the method of recovery of remains (i.e. mechanical digging), the chronological stratigraphic sequence within the gravels is in some doubt (Harrison *et al.*, 1981). Dating of the assemblage by pollen analysis has provided evidence for two periods: early Post Glacial (c. 9,000-8,000 BP) and middle Post Glacial (6,500-5,000 BP) (Harrison *et al.*, 1981). Subsequent radiocarbon dating (Appendix 1) of non-horse faunal remains has cleared up some of the confusion and supports the existence of both Late Glacial/early Post Glacial (c. 10,100 BP) as well as later Post Glacial (c. 500 BP) assemblages.

Horse remains are present from the site and the author has studied them in detail at the HZM. All the available specimens have been 'treated' (i.e. PVA plus alcohol or water) (D. L. Harrison, pers. comm.), and they consist mainly of postcranial bones of various sizes and preservation states (i.e. degrees of mineralisation). A further discussion of size variation in relation to dating can be seen in chapter 5. Four radiocarbon dates (Appendix 1) for the Darent Gravels horses were obtained as part of a previous study; however, only one lies within the Late Glacial/early Post Glacial (c. 9,800 BP), while the other three date to the later Post Glacial (c. 1,100-1,000 BP and c. 400 BP). Unfortunately, the older bone (a "highly mineralised" MTIII: HZM 8.8535) which was found at the lowest level of the pit (2.4-3m deep) was destroyed during conventional dating procedures. Only a photograph survives (D.L. Harrison, pers. comm), from which much of the information regarding this bone was retrieved for the current study. The complete mixed mammalian faunal list includes mammoth, woolly rhinoceros, aurochs, reindeer, red deer, roe deer, fallow deer, human, dog, cat, pig/wild boar, domestic cattle and domestic sheep

Region 11:

Green Craig, Pentland Hills, near Edinburgh, Lothian, Scotland, References: Henderson (1887); Simpson (1887); Ritchie (1920); Macgregor and Ritchie (1939-40); Lacaille (1954); Kitchener and Bonsall (1997)

A rock fissure in the Pentland Hills in which mammalian bones of supposed Late Pleistocene or Post Glacial age were found in 1886 (Henderson, 1887; Simpson, 1887; Ritchie, 1920). The collection is held at NMS, Edinburgh. A recent radiocarbon dating project (Kitchener and Bonsall, 1997) to date extinct Scottish mammals has provided Late Glacial/early Post Glacial dates (Appendix 1) for the Green Craig fauna.

Horse remains are present, and according to Ritchie (1920), bones of at least two individuals are represented A new and important radiocarbon date (Appendix 1) for one of these horses dates to the later Late Glacial (c. 10,200 BP). For a discussion of the implications of this date see section 4 5.2 below. Associated fauna includes reindeer, wolf and fox.

Calton Housing Scheme diggings, Campbeltown, Kintyre, Strathclyde (formerly Renfrewshire), Scotland, References: Lacaille (1954); Neil (1977)

A site (site 3) near Albyn Distillery from which diggings within a 'raised beach deposit' have yielded 'Early Larnian' (i.e. Mesolithic) flint implements as well as mammalian remains. Horse remains (a tooth of a "small breed of wild horse") were recovered in addition to the remains of bovid ("*Bos ?primigenius*") and fox or large dog (Lacaille, 1954).

Cowden Glen, Strathclyde, Scotland, References: Lacaille (1954); Neil (1977)

A 'raised beach' site with "wild" horse remains that possibly date to the early Post Glacial age (Lacaille, 1954). This early Holocene age is indicated by their supposed association with other plant and animal remains which include aurochs.

Region 13:

Cathole Cave, Gower, W. Glamorgan, South Wales [SS 5377 9002], References: McBurney (1959); Campbell (1977)

Cathole is a cave site located on the Gower peninsula, originally excavated by Colonel Wood in the 1860s and subsequently by C. B. M McBurney in 1958-59 and J. B Campbell in 1968. Although no stratigraphy was recorded by Wood, the excavation

yielded artefacts of "Creswellian type" as well as Pleistocene mammals. The Wood collection of mammalian remains is conserved at the NHM. The next sequence of excavations was carried out by McBurney (1959). McBurney's stratigraphical sequence consisted of six layers (A-F) ranging in age from the Late Pleistocene to the Holocene (e.g. Bronze Age); however, the majority of LUP artefacts and faunal remains came from Layer B or B/C interface (i.e. the Late Glacial occupation). Also, Campbell (1977) notes that Mesolithic artefacts were identified from McBurney's B/C and C/D interfaces. The McBurney finds are conserved at the NMW, Cardiff. Cathole Cave was last excavated by Campbell (1977), who, like McBurney (1959), distinguished a multi-layer sequence. The most notable of these layers are LOB and MSB which represent the Later Upper Palaeolithic while the USB/C interface, Layer C, C/D interface and Layer D represent the Mesolithic, based mainly on Mesolithic artefactual and some faunal evidence. Campbell (1977) notes that radiocarbon dating was attempted on fragments of bone and charcoal from his layers LOB and MSB; however, they failed to produce a reliable date. See below for a discussion of the first successful radiocarbon dating of a specimen (a horse tooth) from the McBurney collection. The present author was unable to trace the whereabouts of the Campbell finds which were believed to be conserved in the CUMAA.

Horse material exists in both the Wood and McBurney collections and the present author has studied all available material held at the NHM and NMW. Campbell (1977) does not identify any remains of horse from his 1968 excavations. Horse finds in the Wood collection consist of a lower cheek tooth and two metatarsal splint bones (M.108). Campbell (1977) notes that Wood's large mammal remains are possibly associated with the Later Upper Palaeolithic artefacts; however, they may belong to different periods within the Late Pleistocene (or Last Glacial). Because there is no stratigraphical information, it is difficult to assign a reliable date to this material. McBurney (1959) noted a horse "tooth" among the faunal material from the Late Glacial levels of his excavation; however, it was necessary to study this material thoroughly in order to determine the exact quantity and quality of the horse specimens actually available. The present author identified a total of 11 horse teeth (incisors and cheek teeth) and 1 second phalanx (Phal II) within the McBurney faunal material; however, it was difficult to assess which specimens came from the Late Glacial levels due to the absence of a 'layer conversion table' for McBurney's 1959 excavation season. Despite this, the present author chose (based on preservational colour) two

unwashed cheek teeth to radiocarbon date for the current research, one of which provided a sound Late Glacial date (c. 12,200 BP) (table 4.5).

Taking account of Wood's, McBurney's and his own faunal lists, Campbell (1977) notes that, in addition to horse, the probable Late Glacial faunal assemblage present at Cathole Cave is as follows: giant deer, red fox , arctic fox, brown bear, red deer, reindeer, common lemming and arctic hare. Due to its apparent absence from British Late Glacial deposits, the present author disagrees with Campbell's (1977) assumption that woolly rhinoceros should be included in this fauna. Precise identification to species and dating confirmation must be made before it can be included as part of the Late Glacial assemblage at Cathole. It appears that Cathole has a mixed fauna of both Pleistocene and Holocene species. For example, Campbell (1977) found roe deer in his Layer D as well as *Ovis Capra* and *Bos* sp. in his uppermost Layers E and F. In fact, some of the horse material (e.g. the Phal II) from McBurney's excavations can be attributed to his Holocene Layer E/F. Furthermore, the present author notes that a cutmarked fallow deer bone (M.86) exists in the Wood collection. Since this is not a Late Glacial species, it must either belong to an earlier (perhaps Last Interglacial) or later (perhaps post-Roman) faunal assemblage (Lister, 1984; A. Currant, pers comm.).

Little Hoyle Cave (or Longbury Bank Cave), nr.Tenby, Dyfed, Wales [SS 1118 9998], References: Rollestone *et al.* (1878); Leach (1918); McBurney (1959); Campbell (1977); Green (1986); David (1991)

Little Hoyle is a small cave site situated close to the well-known Later Upper Palaeolithic site of Hoyle's Mouth. It was first excavated in the 1877-78 by Rollestone, Pitt-Rivers and Laws and produced remains of Pleistocene mammals and possible EUP artefacts as well as Holocene finds of pottery and "food debris" (McBurney, 1959). McBurney (1959) began investigating the cave in 1957; and in subsequent excavations in 1958 and 1963 he identified a stratigraphical sequence which included Late Glacial layers (B^1 and B^2) yielding bones, charcoal, and "Creswellian" artefacts. More recently, in 1984-1986, the site was excavated by the National Museum of Wales (NMW), Cardiff and the finds from these excavations are now conserved there (Green, 1986) From these investigations, it was concluded that the assemblage was of Late Glacial age based on faunal, archaeological and radiometric evidence. However, it should be pointed out that some of Green's (1986) evidence (e g. fauna associated with

a pooled radiocarbon date of c. 18,450 BP) can be considered to be pre-Late Glacial Interstadial (i.e. glacial maximum). Furthermore, David (1991) notes that "there are, as yet, no Late Glacial radiometric dates" for Little Hoyle.

Although McBurney (1959) does not include horse in his faunal list for his Late Glacial layers, both the Rollestone, Pitt-Rivers and NMW excavations yielded horse remains, assumed to be of Late Glacial age. On a visit to NMW, the present author located and studied only one horse bone (Phal II- LH86 T5/3/NC344) from Little Hoyle. A combined faunal list of mammalian species supposedly associated with the horse remains from this site includes: brown bear, arctic hare, Norway and arctic lemmings, red fox, reindeer, and the northern vole.

Region 14:

Kendrick's Cave, Llandudno, Gwynedd, Wales [SH 780 828], References: Jackson (1962); Sieveking (1971); Campbell (1977); Davies (1979, 1983, 1991); David (1991); J. Cook and R. Jacobi (pers. comm.)

A coastal cave site of two levels excavated by Kendrick in 1879-80 (Lower Kendrick's Cave) and by Davies in 1977-79 (Upper Kendrick's Cave). During the earlier excavations, a stratigraphic sequence was identified within the Lower Kendrick's Cave and is thought to have consisted of a basal cave earth or clay layer underlying a breccia deposit; however, finds may be of doubtful provenance and association within these levels (Sieveking, 1971). Finds from these excavations include faunal remains (cave earth and breccia levels) as well as human remains and possible LUP artefacts (breccia level), most notably an elaborately incised/decorated horse mandible (see date below) and decorated and/or perforated teeth of bear (now missing), badger, red deer and bovid (*Bos* sp.). The collection is conserved at the BMFH and the Llandudno Public Library, Wales Recent investigations (J. Cook and R. Jacobi, pers. comm.) of the finds (human/faunal remains and decorated specimens) from Kendrick's Cave have yielded new radiocarbon dates (Appendix 1) ranging in age within both the Late Glacial and early Post Glacial periods (c. 12,400-11,800 BP and c. 9,900 BP, respectively), as well as the middle Post Glacial period (c. 5,100 BP).

In addition to the dated horse specimen (a mandibular symphysis with incisors: BM Reg. no. 1959, 12-3, 1) mentioned above, remains of horse were prevalent at Kendrick's Cave. The present author has studied all the available specimens (mainly cheek teeth and incisors, including another [unmodified] mandibular symphysis) at the

BMFH as well as those from the Llandudno Public Library collection (on loan to J. Cook at the BM) and mentioned in Davies (1991). Previous radiocarbon dating of the humanly modified horse specimen (see above) has provided a later Late Glacial date (c. 10,000 BP) (Appendix 1). Furthermore, as part of the current project and in conjunction with the above investigations (J. Cook, pers. comm.), two new radiocarbon dates (table 4.5) on horse were obtained, both of which date to the later Post Glacial (c. 1,000 BP and c. 200 BP). A discussion of the implication of the new dates in relation to the original one is given below (section 4.5.2). Additionally, the mixed-age faunal assemblage (including decorated specimens) is thought to include human, sheep, bovid (*Bos* sp.), red deer, pig, roe deer, red fox, bear, and badger.

Sites with horse material: middle to late Holocene (Late Mesolithic/Neolithic Bronze Age and Iron Age)

Region 1:

Heathery Burn Cave, near Stanhope, Co. Durham, References: Greenwell (1894); Britton (1971); Britnell (1976); Megaw and Simpson (1984)

A cave site investigated by Rev. Greenwell in the late 19th century thought to date to the 8th-7th century BC (= c. 2,750-2,550 BP). Finds include faunal remains as well as Bronze Age artefacts (e.g. "antler cheek pieces"). The faunal collection is held at the NHM. Horse remains are present from the site and the author has examined all the available specimens (two slender metapodials and two worn cheek teeth). Based on the artefactual evidence (e g. horse equipment) at the site, these horses were probably domesticated (Megaw and Simpson, 1984) Additional mammalian faunal remains include dog, red deer, cat, pig, sheep, ox ("*Bos taurus* var. *longifrons*"), and hare (*Lepus timidus*).

Teesdale Cave, Upper Teesdale, Co.Durham [NY 867 311-869 311], References. Simms (1974)

A system of cave fissures originally excavated by the Backhouses and Wallis in 1878-85 and most recently by Simms in 1967-71 During the earlier excavation period, both cave earth and stalagmitic floor deposits of areas A, B, and C were investigated, while Simms investigated other areas (e g areas D, E and under a "swallow hole"). Finds from all excavations include a mixed Post Glacial mammalian faunal

assemblage. The faunal collection is held at the YM. Subsequent pollen studies seem to support a later Post Glacial (i.e possibly Iron Age or later) age for the deposits associated with the fauna in area D (Simms, 1974).

Horse remains are present from Teesdale cave (Backhouse collection 1880, 1886) and the author has studied all available specimens (mainly postcranials) in detail at the YM. Unfortunately, this collection of horse specimens seems to be mixed, e.g. 1) some may be from other cave sites in the area and 2) some have been identified as "ass" or *E. asinus* instead of 'true' horse or *E. caballus*. For example, the present author supports the previous identification of one tooth (possibly not from Teesdale) which definitely did not have caballine features. Due to these discrepancies, it is difficult to assess the status of the "horses" from Teesdale. According to Simms (1974), in addition to horse ("*Equus* sp."), the Post Glacial mammalian faunal assemblage includes (from both excavation periods): pigmy shrew, hedgehog, mole, wolf, red fox, brown bear, marten (*Martes* sp.), stoat, weasel, polecat/ferret , badger, otter, lynx, wild boar, red deer, roe deer, domestic cattle, sheep/goat, brown hare, arctic hare, rabbit, bank vole, and other voles (*Microtus* sp. and *Arvicola* sp.).

Tees Estuary, Co. Durham [(NZ 5024)], References: P. Rowley-Conwy and S. Stallibrass (pers. comm)

Horse remains from this site, a foreshore deposit, have been recently radiocarbon dated and date to the later Holocene (c. 400-300 BP: Appendix 1).

Kirkhead Cave, Grange-over-Sands, Cumbria [SD 391 756], References: Jackson (1953); Wood *et al.* (1970); Campbell (1977); Neil (1977)

A cave site excavated by Wood in 1968-70 and whose occupation deposits are thought to be of Bronze Age or later (perhaps Roman) date. Finds from these excavations include faunal remains as well as later prehistoric artefacts. Campbell (1977) notes that even LUP artefacts were thought to have been found in Layer B. According to Jackson (1953), the faunal assemblage (unprovenanced) includes horse in addition to human, roe deer, red deer, badger, wild boar, ox, goat, dog, and fox. By its composition, this assemblage looks purely Post Glacial in age.

Region 2:

Formby Point, Lancashire [SD 269 070], References: P. Rowley-Conwy and S. Stallibrass (pers. comm.)

Horse remains from this site, a foreshore deposit, have been recently radiocarbon dated and date (Appendix 1) to the later Holocene (c. 400 BP). Similarly, a newly-obtained radiocarbon date (S Stallibrass and P. Rowley-Conwy, pers comm.) on a bovid bone (*Bos* sp.) is very young (c. 150 BP: Appendix 1)

Region 3:

Kirkburn, North Humberside, References: Ambers, Matthews and Bowman (1991)

A Neolithic enclosure site which lies in close proximity to an Iron Age enclosure. Finds within the Neolithic enclosure include human remains and two horse burials. Radiocarbon dating (Appendix 1) of human samples has yielded a Bronze Age date (c. 3,400 BP), while the two horses date to the early Roman period (c. 1,900 BP) (Appendix 1).

Skipsea, near Hull, Humberside, References: Phillips (1829); Armstrong (1923); Sheppard (1923); Gilbertson (1984)

A site in the Holderness area which probably was originally investigated by T. Boynton. A faunal collection ("Presented by Mr. T. Boynton") from this site, simply called "Skipsea near Hull", is held at the YM. All the remains in the YM's collection appear to have the same (peat-stained) preservational state. Interestingly, other faunal remains have been found in or below peat deposits at a Late Pleistocene/early Holocene site called "Skipsea Withow" which had been investigated by Phillips (1829), Sheppard (1923) and Armstrong (1923) (Gilbertson, 1984); however, it is unclear whether these two "Skipsea" sites are the same. A newly-obtained radiocarbon date (S. Stallibrass and P. Rowley-Conwy, pers. comm) is available for Skipsea Withow and it lies within the early Post Glacial (c. 9,500 BP) (Appendix 1).

Horse is present in the YM collection (i.e. Skipsea near Hull) and the author has studied all the available specimens (postcranials, cranials and teeth). In addition to horse, the mammalian faunal assemblage at the YM includes cattle ("*Bos longifrons*"), bear and goat (*Capra* sp) Even though the author did not personally examine the faunal remains from "Skipsea Withow" they are thought to include "elk" or "*Cervus giganteus*" (i.e. giant deer, *Megaloceros giganteus*), reindeer, red deer and "ancient

ox" (or aurochs). It must be noted that this Skipsea Withow assemblage clearly represents an earlier (i e. Late Pleistocene/early Holocene) rather than a later one (i.e. middle Holocene) than that at the Skipsea near Hull site investigated by the author (see above).

Ulrome, near Skipsea, Humberside, References: Munro (1890); Smith (1911); Sheppard (1939); Gilbertson (1984)

One of several possible Neolithic lake dwelling sites in the Holderness area (i.e. West Furze, Round Hill, Barmston, Gransmoor and Little Kelk) originally investigated by T. Boynton in the late 19th century (Munro, 1890; Sheppard, 1939). According to Munro (1890) (at the time) only West Furze and Round Hill had been subjected to in-depth investigations. Gilbertson (1984) notes that the stratigraphy at West Furze lake dwelling site consisted of "undifferentiated peats" (i.e. peaty detritus muds), while that of the Round Hill site consisted of a "calcareous freshwater 'marl' deposit" lying in-between two peat layers. Finds from these sites include faunal remains as well as human remains and artefacts. A faunal collection from a site simply called "Ulrome" is held at the NHM.

Horse remains are present from "Ulrome" and the author has studied the available specimens (1 partial MTIII, 1 partial tibia and 1 partial skull with cheek teeth: all ARC 1970.3035) in detail at the NHM. Unfortunately, the remains cannot at present be attributed to any one specific lake dwelling site; however, Munro (1890) notes a "small breed" of horse amongst the mammalian faunal assemblage from West Furze which is also thought to include cattle (including "*Bos longifrons*"), aurochs, dog/wolf, beaver, pig, sheep/goat, deer, and ?otter. Similarly, the NHM "Ulrome" faunal assemblage includes most of the above including the deer (an antler) which was subsequently identified as reindeer. Upon further investigation prompted by the author, however, A. Currant (pers. comm.) regards this specimen as elk (*Alces alces*) rather than reindeer. This identification is possibly of stratigraphical significance because elk is not recorded in Britain after the early Holocene (Lister, 1984). Interestingly, however, this idea must be revised based on newly-obtained radiocarbon dating evidence (S Stallibrass and P. Rowley-Conwy, pers. comm.): a middle Holocene date (c. 5,700 BP: see Appendix 1) for an elk from Barry's Island (see above).

Buckland's Windypit, Rydale, near Helmsley, N. Yorkshire, References: Hayes (1962)

One of a group of fissure caves originally explored by E. P. Fitton in 1949. Finds from the fissures include faunal remains and Bell Beaker artefacts (e.g. pottery). Radiocarbon dating of hazel charcoal from the nearby Antoft's Windypit has yielded a date (Appendix 1) within the Late Neolithic/Beaker period (c. 3,700 BP). Horse remains (mainly metapodials) are present from Buckland's Windypit in addition to those of aurochs (from Fissure 'S'), ox, sheep/goat, pig, red deer, roe deer, dog, fox, badger, and wild boar. Hayes (1962) considers the horse remains to represent "pony"-sized animals (i.e. with a withers height of 12-13 hands).

Cave near Grassington (?Dowkerbottom), N. Yorkshire, References: Jackson (1931); Denny (1860)

A cave site investigated by Mr. Bennett from which remains of mammals were recovered (Jackson, 1931). Horse is included amongst the "mixed" mammalian assemblage of unknown age. The associated remains include bear, lynx, fox, pig, sheep and ox (Jackson, 1931), an assemblage which looks Post Glacial in age.

Fox Holes, Clapdale, Clapham, N. Yorkshire [SD 756 714], References: Jackson (1953, 1962); Neil (1977); T. Lord (pers. comm.)

A cave site near Ingleborough Cave which yielded artefacts and mammalian remains from two deposits. Finds from the burial deposit include pottery, artefacts and animal remains which possibly date to the Neolithic (Neil, 1977). T. Lord (pers. comm.) holds this collection privately.

Horse remains are present and according to Jackson (1953), consist of the "slender leg bones of at least five horses". In addition to the horse, the faunal assemblage in the "grave" includes red deer, while the remains from the "debris within the cave" include "wild ox" (aurochs), giant deer, red deer, roe deer, wolf and wild boar (Neil, 1977). The contents (i.e. species composition) described here, with the exception of giant deer if it was correctly identified, appear to point largely to a Post Glacial age for the assemblage.

Staple Howe, near Malton, East Riding, N. Yorkshire, References. Brewster (1963); King (1963); Neil (1977)

An Iron Age (Period I) palisaded settlement site excavated by Brewster in 1951-56 and 1958. According to Brewster (1963), the majority of the faunal remains and artefacts (e.g. small finds and pottery) were retrieved "from the packing of the fence slots" and not "from the pits or hut floors". The faunal collection is held at the NHM. Subsequent radiocarbon dating of charred grain from phase II ditch deposits has yielded a secure Iron Age date (c. 2,400 BP) (Appendix 1).

Horse remains are present from Staple Howe and the author has studied all the available specimens (cheek teeth and postcranials) in detail at the NHM. In addition to horse, the faunal assemblage includes human, ox, pig, sheep/goat, red deer, roe deer, dog, wolf, fox, badger, cat, beaver and water vole.

Region 5:

Giants' Hills, Skendleby, Lincolnshire, References: Jackson (1936b); Phillips (1936); Neil (1977); Ashbee (1984)

A Neolithic long barrow site investigated by Phillips (1936) which yielded faunal remains from the ditch. Available radiocarbon dates (Appendix 1) for the barrow lie within the Neolithic (c. 4,400-4,300 BP). Horse remains, however, are only present from the "Post-Beaker levels" of the ditch and possibly date to the Bronze Age rather than the Neolithic (Phillips, 1936; Neil, 1977).

Region 6:

Drayton Cursus, near Abingdon, Oxfordshire [SU 490 945], References: Lambrick and Moore (1987); Ainslie and Wallis (1987); Hedges *et al.* (1990: AM11); P. Bradley (pers. comm), B. Wilson (pers. comm.)

A cursus site excavated by the Abingdon Area Archaeological and Historical Society in 1977-83 and most recently by Lambrick and Moore on behalf of the Oxford Archaeological Unit in 1985-86 (P. Bradley, pers. comm). Excavations of the eastern cursus ditch during the 1980's yielded faunal remains as well as artefacts (e g. flint and pottery) from deposits (gravelly clay) thought to be of Neolithic age (Ainslie and Wallis, 1987). Subsequent radiocarbon dating of the fauna from this deposit has produced conventional dates (Appendix 1) which support a Neolithic age (c. 5,000-4,800 BP) Also, further (accelerator) radiocarbon dating (Appendix 1) on

environmental samples from the eastern cursus bank and ditch produced a combined date of c. 4,700 BP.

Horse remains are present from Drayton Cursus in all contexts (i.e. Neolithic, Romano-British and Saxo-Medieval). B. Wilson (1987; pers. comm.) identified one horse bone (scapula fragments) supposedly from the Neolithic deposits of the eastern ditch, and this bone was included in a bulked sample of animal remains that dates to within the Neolithic age range mentioned above (Appendix 1). However, because this bulked date (HAR-6477) is considered as "unexpectedly early" for this Neolithic deposit, the horse bone is now thought to have been either "reworked" from the underlying Pleistocene (Late Glacial) gravels or a representative of "very early example of horse" (i.e. pre-Late Glacial horse) (P. Bradley, pers. comm.; Hedges *et al.*, 1990: AM11). To complicate matters even further, the horse specimens were completely destroyed for dating purposes and thus, they are no longer available for re-investigation and re-dating (B. Wilson, pers. comm.). These problems will be dealt with in more detail in section 4.5.2. In addition to horse, the mammalian fauna from the eastern cursus ditch deposit includes cattle, aurochs, pig, and red deer. Furthermore, horse remains from later deposits have been dated to the later Holocene (post-Saxon) period (c. 400 BP: Appendix 1). Additionally, the fauna from the Saxo-Medieval group includes cattle, sheep, pig, dog and cervid.

Lavender's Pit, Laleham, Middlesex [TQ 057 675], References: Simons (1973)

A supposed Neolithic or Bronze Age riverside settlement site on gravel workings which was first investigated by Simons in 1956. A stratigraphical sequence was determined and consisted of Pleistocene river-terrace gravels underlying peat (supposedly early Holocene), sand/gravel (Holocene) and soil (Holocene) levels (Simons, 1973). Dredging of the gravels within the pit yielded abundant faunal remains (Pleistocene and Holocene) as well as human remains and Neolithic artefacts. The faunal collection is held at the NHM. Based on their preservational state (i.e. peat-stained), Simons (1973) considers most of the finds and animal remains to have originated from this peaty layer, and therefore they probably date to the "early" or middle Holocene (i e. Neolithic or Bronze Age). According to him, "most of the remains are of similar preservation".

Horse remains (all "treated" and peat-stained) are present from Lavender's Pit and the author has examined all the available specimens (postcranials, cranials and

cheek teeth: all ARC 1970 3165) at the NHM. In addition to horse, the mixed Pleistocene/Holocene mammalian faunal assemblage includes wolf/dog (*Canis* sp), red fox, pine marten, badger, pig, sheep/goat, red deer, aurochs, domestic cattle, mammoth, and reindeer.

Tolpit's Lane, Rickmansworth, Hertfordshire, References: Burleigh *et al.* (1982b); Bowman *et al.* (1990)

An open site investigated by the Rickmansworth Historical Society in 1971. Faunal remains (some with cutmarks) were recovered from peaty deposits overlying Pleistocene gravels which form a terrace of the nearby River Colne. The faunal collection is held at the NHM. A study of the pollen associated with the remains indicates that the assemblage dates to Zone VIIa or the Atlantic (c. 7,500-5,000 BP). Furthermore, subsequent radiocarbon dating of the fauna has yielded one date (Appendix 1) which lies within the Neolithic (c. 5,500 BP).

Horse is present from Tolpit's Lane and the author has studied the only available specimen (a partial femur: ARC 1975.5262) in detail at the NHM. It is not known, however, whether this bone was found in close association with the other faunal remains (including the dated aurochs). In addition to horse, the faunal assemblage includes red deer, roe deer, domestic cattle and aurochs.

Region 7:

Etton, Maxey, near Peterborough, Cambridgeshire, References: Pryor *et al.* (1985); Pryor (1988); Clutton-Brock and Burleigh (1991b); Hedges *et al.* (1996: AM21)

A Neolithic causewayed camp (enclosure) discovered in 1976 and excavated by Pryor in 1981 and 1982-84. Horse is present at Etton from a supposedly secure Neolithic context, and consists of a skull which appeared to have been "intentionally buried in a pit directly underneath a red deer antler pick" (Clutton-Brock and Burleigh, 1991b) These faunal remains (horse and red deer) have been radiocarbon dated and unexpectedly, the reliable dates (Appendix 1) lie within a Late Bronze Age range (c. 3,100-3,000 BP) rather than an earlier Neolithic one. In addition to horse and red deer, the mammalian faunal remains include cattle and roe deer.

Fengate sites, Peterborough, Cambridgeshire, References: Pryor (1974, 1975, 1978, 1980, 1984); Neil (1977); Harman (1978); Biddick (1980)

Fen-margin settlement sites in the Fengate area investigated by Pryor (1974, 1975, 1978, 1980, 1984) which are thought to date from the Neolithic (enclosure system: c. 4,800-3,800 BP) to the Romano-British period. Finds include faunal remains from the Storey's Bar Road (Late Neolithic/Bronze Age), Newark Road (Bronze Age) and Cat's Water (Iron Age/Romano-British) subsites. The faunal collection is said to be held at the Peterborough Museum. Radiocarbon dating of material from the Storey's Bar Road and Newark Road sites has yielded dates (Appendix 1) ranging within the later Bronze Age (c. 3,000-2,800 BP). Horse remains (mainly postcranials) are present from all subsites; however, the Iron Age occupation area has yielded the largest sample of specimens (including 15 metapodials). In addition to horse, the faunal assemblage from the Storey's Bar Road and Newark Road sites includes cattle, pig, sheep/goat, dog, red deer, aurochs, ?wild pig, badger, wolf, and fox.

Lingey Fen, Grantchester, near Cambridge, Cambridgeshire, References: Burleigh *et al.* (1982b); Bowman *et al.* (1990)

An open site located in the Fen Basin of East Anglia, an area which consists of an extensive hollow filled with Holocene peat. Investigations of this site by Legge have yielded faunal remains from both "upper" and "lower" peat deposits. Radiocarbon dating of non-horse faunal samples has yielded dates (Appendix 1) ranging from the middle (c 6,600 BP and c. 4,900 BP) to later Holocene (c. 2,900-2,800 BP). Horse remains are present from Lingey Fen and one specimen from the "upper" peat has been radiocarbon dated (Appendix 1) to the later Holocene (c. 2,300 BP). In addition to horse, the mammalian faunal remains include aurochs and red deer.

Swaffham Fen, Cambridgeshire [TL 540 673], References: Godwin (1978); Stuart (1982)

An open site located in the Fen Basin of East Anglia, an area which consists of an extensive hollow filled with Holocene peat. Extensive pollen and radiocarbon studies on deposits in this area (Godwin, 1978; Stuart, 1982) indicate deposition largely in the period c. 7000-2000 BP (i e. subzone VIIa/zone VIII or Fl IId/early

FIIII). Faunal remains collected from fen peat at Swaffham in the 19th/early 20th centuries are now conserved at the SMC and the BGSM.

Horse remains are present from Swaffham and the author has examined all available specimens (cheek teeth, cranials and postcranials) in detail. The collection at the Sedgwick is interesting because it appears to represent at least two or three individuals, however, it is unknown whether these individuals are associated. Also, one specimen (an MTIII: BGS/GSM 59640) appears to exhibit evidence of human modification (i.e cutmarks). As part of the current project, one specimen was chosen for radiocarbon dating and its date (table 4.5) unexpectedly lies securely within the later Holocene (c. 600 BP) rather than the middle Holocene. Other mammalian faunal remains from the fen peat include pig, wolf, brown bear, otter, beaver, roe deer, red deer, and aurochs.

Feltwell Fen, near Littleport, Norfolk [TL 650 900], References: Fox (1923); Godwin (1978); Stuart (1982)

An open site located in the Fen Basin of East Anglia (see above). Faunal remains were collected from both the fen peat as well as the underlying Pleistocene gravels at Feltwell. The faunal collection is conserved at the MM. Previous radiocarbon dating of the fauna from the gravel deposits has yielded a Late Glacial date (c. 11,600 BP: Appendix 1).

Horse remains are present from both the peat and gravel deposits at Feltwell and the author has studied all the available material at the MM. Three postcranial bones (2 MTIII and 1 Tibia: all "treated") are characteristically peat-stained; however, one bone (a very large femur) appears to have a preservation which indicates derivation from the gravels rather than from the peat. As part of the current project one specimen (probably from the peat) was radiocarbon dated and unexpectedly it produced a later Holocene date (c. 300 BP) (table 4.5). Unfortunately, a full faunal list is not available for the remains collected from the peat deposits of Feltwell; however, in addition to horse, the Pleistocene fauna from the gravels includes reindeer

Grimes Graves, Weeting, Norfolk [TL 817 898], References: Sieveking *et al.* (1973); Neil (1977); Mercer (1981), Clutton-Brock and Burleigh (1991b); Legge (1981, 1992)

An immensely important Late Neolithic/Bronze Age site excavated by Armstrong in 1921-39, by Mercer on behalf of the Department of Environment (DoE)

in 1971-72 and by Longworth and Sieveking on behalf of the BM in 1972-76. Finds from the flint mines (Late Neolithic) and the midden deposits (Bronze Age) include faunal remains and artefacts. The faunal collection is held at the British Museum and the NHM.

Horse remains are present at Grimes Graves from both Late Neolithic and Bronze Age contexts. The author has briefly examined a small assemblage (a horse skull and a mandibular ramus with deciduous cheek teeth) held at the NHM which was recovered from the 1976 investigation of the Neolithic deposits of the flint mine. Clutton-Brock and Burleigh (1991b) have studied this skull in detail and have determined that it came from an aged mare (i.e. an adult female) which had been deliberately buried in a pit and according to them, it almost certainly represents the "earliest domestic horse yet found in Britain". Subsequent radiocarbon dating (Appendix 1) of this specimen securely dated it to the Late Neolithic/Beaker or Early Bronze Age (c. 3,700 BP). In addition to horse, the Neolithic and Bronze Age deposits yielded other mammalian faunal remains including those of cattle, pig, sheep/goat, dog, red deer, roe deer and voles.

Near Poor's Heath (Flempton), Risby, Suffolk, References: Vatcher and Vatcher (1976); Cornwall (1976); Neil (1977)

A Beaker/Early Bronze Age round barrow site excavated by Vatcher and Vatcher (1976) in the 1960's. Finds include artefacts (e.g. pottery) as well as midden material which consist mainly of faunal remains. The faunal collection is held at the SAU. According to Vatcher and Vatcher (1976) the barrow was constructed and used during the Beaker/Early Bronze Age (c. 3,550-3,350 BP).

Horse remains are present from Poor's Heath and the author has studied all available specimens (a cheek tooth and an innominate pelvis) in detail at the SAU. According to Cornwall (1976), seven specimens of horse (mainly teeth) were found in total; however, the present author was unable to locate most of this collection (e.g. several teeth) at the SAU. In addition to horse (8% of 179 bones total), the mammalian faunal assemblage includes cattle, domestic pig, sheep/goat, red deer, roe deer, dog, hare, badger, fox, and possibly aurochs and wild boar.

Hurst Fen, Mildenhall, Suffolk, References: Clark (1960); Higgs (1960); Grigson (1966)

A primary Neolithic settlement site excavated by Clark in 1954 and 1957-58 which yielded faunal remains including horse (one cheek tooth) (Higgs, 1960). The faunal collection is supposed to be held at the CUMAA; however, the present author could not locate the horse specimen on a recent visit there. The additional mammalian fauna is thought to include bovid (possibly aurochs), sheep and pig.

West Row Fen (= Mildenhall 165), Mildenhall, Suffolk, References: Martin and Murphy (1988); Olsen (1994)

A Bronze Age habitation site (a "village") excavated by Martin on behalf of the Suffolk Archaeological Unit (SAU) and English Heritage in 1982-86. Finds, mainly from sandy deposits overlying chalk and underlying peat, include abundant faunal remains (many humanly modified) as well as Mesolithic, Neolithic and Bronze Age artefacts. The faunal collection is held at the SAU. Olsen (1994) dates the main occupation of the site to the Early Bronze Age.

Horse remains are present from West Row Fen and the author has studied all available specimens in detail at the SAU. According to Olsen (1994), 15 specimens of horse (seven teeth and eight bone fragments) were found in total; however, the present author was unable to locate a significant proportion of this collection (e g. vertebrae and several teeth) at the SAU. This small osteological collection did not allow Olsen (1994) to determine whether these horses were wild or domesticated; however, she notes that one bone (a fragmentary metapodial) exhibited evidence of butchery. For a further discussion of the wild versus domestic horse issue see section 4.5.2 (this chapter) as well as chapter 6. In addition to horse, the faunal assemblage includes cattle, sheep, goat, pig, dog, hare (*Lepus* cf *capensis*), red deer, roe deer, aurochs, wild cat, red fox, hedgehog, mole, and possibly water vole.

Lion Point (Jaywick Sands), Clacton, Essex, References: Warren *et al.* (1936); Longworth *et al.* (1971), Neil (1977)

A Neolithic site consisting of "pit dwellings", "cooking holes" and "hearths" was investigated by Warren in the 1930's. Finds include faunal remains and artefacts (e g. grooved ware) The faunal collection is held at the NHM. Horse remains are present from the site and the author has studied all available specimens (mainly cheek teeth).

One specimen (a partial mandible with two cheek teeth intact: ARC 1970 3044) is recorded as coming from the "buried Neolithic surface", while the other cheek teeth are recorded as being found "*in situ* below peat". Additional faunal remains include pig, aurochs, ox, red deer and sheep/goat.

Stone Point, Walton-on-the-Naze, Essex, References: Neil (1977)

A supposedly Neolithic occupation site investigated by S. Hazzledine Warren which yielded faunal remains (Neil, 1977). The faunal collection is held at the NHM. Horse remains are present from the site and the author has examined all available specimens (cheek teeth and postcranials). Additional mammalian faunal remains include aurochs, ox, sheep/goat, and red deer.

Region 8:

Plateau Rift Cave, Torbryan, Devon [SX 81 67], References: A. Roberts (pers. comm.)

A cave site or "rift" very near Broken Cavern and Three Holes Cave in the Torbryan Valley which was excavated by the British Museum in 1991-92. Two human skeletons associated with charcoal, a flint scraper and a horse leg bone (right MCIII with splint bones) were discovered in a 'burial chamber'; and according to A. Roberts (pers. comm.), a subsequent radiocarbon date confirms that the burials are Middle Bronze Age instead of Neolithic. The finds are held at the BMFH where the present author has briefly studied the horse remains.

Nor'Nour, Isles of Scilly, References: Dudley (1967), Butcher (1970); Turk (1967, 1971); Pernetta and Handford (1970); Neil (1977)

A Late Bronze Age/Early Iron Age settlement site excavated by Dudley in the 1960's and by Turk in 1969-70. No horse remains are noted from Dudley's excavations; however, a small amount of remains (mainly cheek teeth) were discovered from Sites D (East Section of midden) and E (strip 5) during the 1969-70 investigations of the site.

Region 9:

Charterhouse Warren Farm Swallet, Blagdon, Mendip, Somerset [ST 4936 5458], References: Everton (1975); Clutton-Brock (1986)

An cave swallet site excavated by Everton in 1971 and 1974 which yielded human as well as faunal remains thought to date to the Bronze Age or later. The faunal collection is held at the WM. A radiocarbon date for aurochs found in 1974 lies within the Early Bronze Age (c. 3,200 BP· Appendix 1). Horse remains are recorded from the faunal assemblage; however, on a recent visit to the WM, the present author was unable to locate any horse specimens from this site. In addition to horse and aurochs, the faunal assemblage is thought to include ox, sheep, pig, red deer, roe deer, hare, and rabbit.

Great Oone's Hole (or Cave), Cheddar, Somerset [ST 469 538], References: Campbell (1977); C. Hawkes (pers. comm.)

A cave site excavated by Porch c. 1902 and subsequently by Hawkes and Tratman. Finds from the Porch excavation include possible LUP artefacts. A collection of faunal material which possibly dates to the Bronze Age (based on associated pottery) is held privately (C. Hawkes, pers. comm.). Horse remains are present from the Great Oones's Bronze Age assemblage and the author has examined the available horse specimens (one Phal II and one Phal III).

Swildon's Hole, Mendip, Somerset, References: Burleigh *et al.* (1982a, 1982b)

A cave site whose deposits yielded horse remains which have been radiocarbon dated (Appendix 1) to the later Holocene (c. 900 BP). Another date for the site, however, lies within an earlier part of the later Holocene (c. 2,000 BP: Appendix 1).

Eldon's Seat, Encombe, Dorset, References: Cunliffe and Phillipson (1968); Neil (1977)

A Late Bronze Age ("Periods I, II, and III") or later occupation (settlement) site which was excavated by Cunliffe and Phillipson in 1964-66. Finds from all three periods include faunal remains as well as Deverel-Rimbury pottery The faunal collection is held at the DCM, Dorchester. According to Cunliffe and Phillipson (1968), occupation of the site probably occurred during the seventh century BC (= c. 2,650-2,550 BP) or earlier. Previous radiocarbon dating supports an occupation during

the Late Bronze Age/Early Iron Age (c. 2,400 BP). New radiocarbon dates for the faunal remains are awaited.

Horse remains (mainly teeth and few postcranials: 28 total) are present from Eldon's Seat (Periods I and II) and the author has examined a significant proportion (14 out of the 28 identified) of the specimens at the DCM. Due to the wear on some of the cheek teeth indicating old age, Cunliffe and Phillipson (1968) consider the horses at Eldon's seat to have been domesticated animals which were probably kept for work rather than food. Although the present author likewise identified very worn teeth in the collection, it must be noted that there is also evidence for younger animals (e.g. unworn and deciduous teeth and juvenile/subadult bones). In addition to horse, the mammalian faunal assemblage includes pig, ox, sheep/goat, dog, and red deer.

Gussage All Saints, Dorset, References: Neil (1977); Wainwright (1979b); Harcourt (1979b)

An Iron Age (three phases) settlement site excavated by Wainwright (1979b). Finds include abundant horse remains from all phases. According to Harcourt (1979b), unlike the other species found on site (e.g. cattle, sheep and pigs), there was an absence of horse remains representing young animals (i.e. juvenile bones). This suggests that "no breeding of horses was practised" at Gussage All Saints, and that possibly these were free-living animals (maybe feral or wild) which were "periodically rounded up, caught and trained" (Harcourt, 1979b). A similar picture of horses is supposedly seen at the Iron Age sites of Danebury, Hampshire (see below) and Longbridge Deverill, Wiltshire However, Neil (1977) suggests an alternative hypothesis that sees "self sufficient" groups of horses being bred/kept, but away from the settlement site. An in-depth discussion this and other issues relating to the domestication of the horse can be found in chapter 6.

Maiden Castle, Winterborne St. Martin, Dorset [SY 669 884], References: Wheeler (1943, 1972); Jackson (1943); Sharples (1991); Ambers *et al.* (1991); C. Grigson (pers. comm)

An ancient hill-top fortification with a Neolithic causewayed enclosure and bank-barrow located near Dorchester which was excavated by Wheeler in 1934-37 and more recently by Sharples in 1985-86. Deposits excavated during the earlier campaigns yielded faunal remains and artefacts from three main periods of occupation:

the Neolithic, Bronze Age, and Iron Age/Romano-British. However, Wheeler (1972) also notes evidence of a post-Roman (i.e. Saxon) "visitation" to the site. The main focus of the present research is Wheeler's faunal collection which is held at the NHM. Radiocarbon dating (Ambers *et al.*, 1991) of charcoal as well as animal and human remains from the 1980's excavations at Maiden Castle ("early prehistoric contexts" only) has yielded dates (Appendix 1) which lie mainly within the Neolithic/Beaker range (c. 5,000-3,500 BP).

Horse remains are present from Maiden Castle (Neolithic, Bronze Age and Iron Age deposits) and the author has studied the available specimens in detail at the NHM. Even though Jackson (1943) notes that five specimens (maxilla fragment, two incisors, one Phal I, and one humerus) came from the Late Neolithic B to Early-Middle Bronze Age levels, he considers none of them to be "stratigraphically earlier than the Beaker period". Also, C. Grigson (pers. comm.) does not believe that any Neolithic provenanced horse exists from Maiden Castle. For the current project, two specimens were chosen for radiocarbon dating (table 4.5) and they now securely date to the later Holocene (i.e. Iron Age/Romano-British and later) (c. 2,300 and c. 1,000 BP). The implications of these dates will be discussed further in section 4.5.2. In addition to horse, the faunal assemblage from Neolithic-Bronze Age levels includes ox, roe deer, red deer, dog, sheep/goat and pig.

Mount Pleasant, Dorset, References: Neil (1977); Wainwright (1979a); Harcourt (1979)

A causewayed enclosure/henge site excavated by Wainwright in 1970-71. Finds include faunal remains and artefacts (e.g grooved ware) from seven different archaeological features (see Appendix 1 and below) and four separate chronological periods: Late Neolithic, Beaker, Bronze Age and Iron Age. The faunal collection is held at the DCM, Dorchester. Radiocarbon dating of faunal and charcoal samples from the older deposits within the features mentioned above (e.g enclosure ditches) has yielded dates (Appendix 1) which support a Late Neolithic/Beaker age range (c. 4,100-3,300 BP) for the site

Horse remains are present only from Late Neolithic (c 3,950 BP) and Iron Age (c. 2,050 BP) levels at Mount Pleasant and the author has examined all available specimens (mainly postcranials) in detail at the DCM Harcourt (1979) considers the Late Neolithic remains to represent wild rather than domesticated horses simply

because, as at other Neolithic sites with horse, "there is no evidence to the contrary". The exact provenance of these Late Neolithic remains (one Phal II and one cheek tooth) is not known to the present author with certainty; however, Wainwright (1979) records horse within primary silts of the west entrance enclosure ditch (see Appendix 1 for associated radiocarbon dates: c. 3,700 BP) as well as within the aeolian deposit (?layer 9) of the north entrance enclosure ditch (see Appendix 1 for associated radiocarbon dates: c. 3,900-3,600 BP) The associated Late Neolithic mammalian faunal remains include red deer, pig, ox, sheep/goat, dog, aurochs, wild pig, and red fox. Furthermore, the author noticed that the remains of both horse and red deer from the Late Neolithic levels exhibited a distinctive preservation type (i.e. a golden yellow colour), suggesting that they originated from the same deposit/horizon.

Thickthorn Down (Gussage St. Michael), Cranborne Chase, Dorset, References: Jackson (1936a, 1943a); Carreck (1955); Neil (1977); Ashbee (1984)

A Neolithic earthen long barrow site which yielded faunal remains from the long barrow itself (barrow number 163a) as well as from the nearby ditch. Previous radiocarbon determinations (Appendix 1) for faunal remains has yielded a secure Neolithic date (c. 5,200 BP). Horse remains are present from the upper deposits of the ditch which probably date to the Early Bronze Age/Beaker period rather than the Neolithic. According to Jackson (1936a, 1943a), these remains (teeth and postcranials) represent a "small horse of *E. agilis* type" (see chapter 2). The mammalian faunal assemblage is also thought to include ox, pig, sheep, fox, red deer, and roe deer.

Wor Barrow, Cranborne Chase, Dorset, References: Pitt-Rivers (1898); Grigson (1966); Neil (1977); Ashbee (1984)

A Neolithic earthen long barrow excavated by Pitt-Rivers in 1893-96. Finds include faunal remains, some of which are held at the SSWM. Radiocarbon dates (Appendix 1) for faunal remains from the ditch are available and they lie within the Neolithic (c 4,700 BP).

Horse remains (mainly postcranials) are known to have been recovered from all levels of the ditch and Grigson (1966) and Neil (1977) highlight one particular specimen (a partial ulna) which was supposedly the deepest find of horse in the ditch (see Appendix 1 for associated dates) Unfortunately, the current author has been unable to trace the horse remains from the Wor Barrow in the Pitt-Rivers collection

held at the SSWM It is possible that they are held elsewhere; however, due to time constraints, the author has been unable track them down at another museum. Additional faunal remains are thought to include human, ox, sheep, red deer, roe deer and dog.

Danebury Hillfort, Hampshire, References: Cunliffe and Poole (1991); Grant (1991)

An Iron Age (four phases: Early, Middle, Late and Latest) hillfort site excavated by Cunliffe most recently in 1969-78 and 1979-88. Finds include a good sample of horse remains from all phases. According to Grant (1991), "the lack of neo-natal animals in all phases and of juvenile animals in all but the late phase, together with the predominance of males, suggests the possibility that these animals were not being bred at Danebury".

Avebury, Wiltshire [SU 103 700], References: Smith (1965); Neil (1977); C. Conybeare (pers. comm.)

A Neolithic henge monument which yielded faunal remains which are held at the Alexander Keiller Museum, Avebury (Smith, 1965). Horse remains are supposedly present in the upper levels which date to the Bronze Age or later (Neil, 1977); however, the present author has been unable to trace their whereabouts. C. Conybeare (pers. comm.) of the Alexander Keiller Museum could not locate the Avebury horse specimens in her collection. Furthermore, Smith (1965) notes no horse from the "Avebury Monuments".

Boscombe Down, Wiltshire, References: Jackson (1937); Neil (1977)

A Late Bronze Age enclosure site which yielded faunal remains as well as artefacts (e.g. Late Bronze Age [Deverel-Rimbury] pottery). The faunal collection is held at the NHM. Horse remains (all "treated") are present from the site in the form of one Phalanx I and one Phalanx II (ARC 1971.5002) which the author has studied in detail In addition to horse, the faunal assemblage includes dog, ox, sheep, pig, goat, and roe deer.

Durrington Walls, Durrington, Wiltshire [SU 150 437], References: Stone *et al.* (1954); Wainwright and Longworth (1971); Harcourt (1971)

A Late Neolithic henge monument site located on the southern edge of Salisbury Plain excavated in 1952 by Stone and by Wainwright in 1966-68. This account will deal mainly with the faunal remains recovered from the 1966-68 excavations which are held at the SSWM. According to Harcourt (1971), excavations yielded faunal remains in association with grooved ware which can be separated into three groups: 1) those from "the various features of the Neolithic levels" (i.e. Northern Circle, Southern Circle and environs, primary silts of the ditch [layers 5-8], the Midden, and the old land surface under the bank); 2) those from the Iron Age "Packway Enclosure" and 3) those from the "Iron Age settlement north of the Northern Circle". Previous radiocarbon dating on charcoal and faunal remains has yielded dates (Appendix 1) that range within the middle Holocene or later Neolithic (c. 4,600-3,600 BP).

Horse remains are present from both Neolithic and Iron Age deposits at Durrington Walls and the author has examined all the relevant specimens from Neolithic levels at the SSWM. According to Harcourt (1971), three animals are represented by the elements found and he considers these horses to be wild rather than domesticated. These specimens (postcranial and cheek teeth: all no. 532 217/1971) are in a good state of preservation and all are very similarly preserved (i.e. all are a yellowish/white colour: see fig. 4.5). For the current project, three specimens were chosen for radiocarbon dating and the dates (table 4.5) all lie within the later Holocene or Bronze Age/Iron Age (c. 3,000-2,100 BP). The associated (i.e. from Neolithic contexts) fauna includes pig, ox, sheep/goat, dog, aurochs, red deer, roe deer, badger, pine marten, and water vole. Interestingly, the present author noticed that one beaver bone exhibited evidence of human modification (i.e. cutmarks).

Easton Down Long Barrow, Bishop's Cannings, Wiltshire, References: Whittle *et al.* (1993); Noddle (1993); Whittle (pers. comm)

A Neolithic downland monument site excavated by Whittle *et al.* (1993) who consider it to be later than that of Horslip, West Kennet (see this section). Finds include faunal remains which are currently held by the excavators, although they are destined for the DM (Whittle, pers. comm) Subsequent radiocarbon dating for faunal remains has produced dates which lie within a Neolithic range (c. 4,500-3,900 BP: Appendix 1)

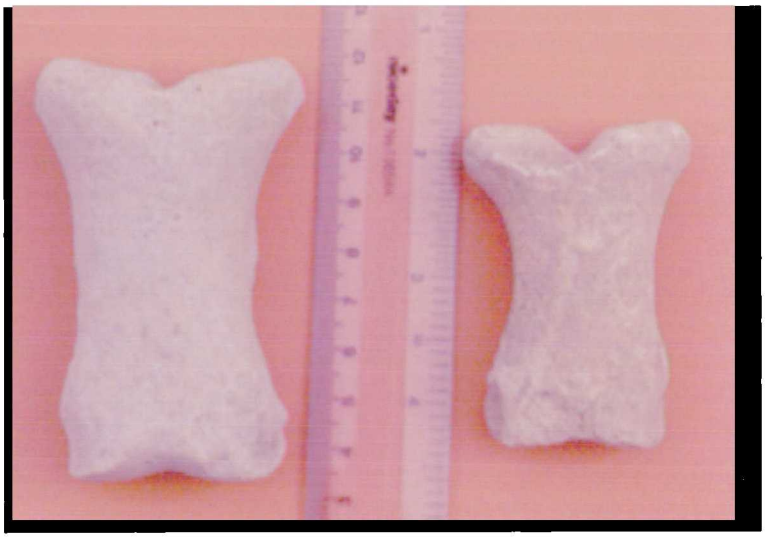

Fig. 4.5. Horse specimens from Durrington Walls, Wiltshire (held at Salisbury and South Wiltshire Museum). Two newly dated and differently-sized first phalanges. Left: a fore phal I; right: a hind phal I (nos. 532 217/1971). (see table 4.5 for new radiocarbon dates).

Horse remains (two bones) are present from Easton Down in the tertiary fill of the South Ditch (Trench A) (Noddle, 1993); however, due to time constraints, the present author was unable to personally study and date these specimens. In addition to horse, the mammalian faunal assemblage includes cattle, pig, sheep/goat, dog, roe deer, and red deer.

Fussell's Lodge Long Barrow, Wiltshire [SU 1915 3246], References: Ashbee (1966); Grigson (1966); Ashbee (1984)

A Neolithic earthen long barrow excavated by Ashbee in 1957. Finds include faunal remains (identified by Grigson, 1966) and artefacts found in a Neolithic context. The faunal collection is held at SSWM. One radiocarbon date on charcoal (Appendix 1) has been obtained and lies within the middle Holocene or Early Neolithic (c. 5,200 BP).

Horse is present from Fussell's Lodge and the author has studied the only available specimen at the SSWM. According to Grigson (1966), this poorly preserved specimen (an upper cheek tooth: FUS57 1ES 2, 88/1963) was found in association with a (possibly intrusive) fallow deer bone in a Neolithic context: "in the surface of the flint mortuary house cover". This tooth has now been radiocarbon dated as part of the current project and dates (table 4.5) unexpectedly to the later Holocene or later Bronze Age (c. 2,900 BP). In addition to horse and fallow deer, the mammalian faunal remains provenanced within a Neolithic context include domestic ox, red deer and sheep/goat.

Hemp Knoll, Wiltshire, References. Clutton-Brock (1986)

A site with horse remains which possibly date to the Neolithic and the Romano-British periods. The remains are held at the NHM and the present author has examined the available specimens (cheek teeth and a vertebra). A radiocarbon date (Appendix 1) for the site lies within the Neolithic (c. 4,600 BP). Also, according to Clutton-Brock (1986), an aurochs bone from the site dates to the Early Bronze Age (c. 3,800 BP: Appendix 1). Additional mammalian faunal remains include pig, ox, deer, hare and sheep goat.

Marden Henge, Wiltshire, References: Wainwright *et al.* (1971); Harcourt (1971a); Neil (1977); Castleden (1992)

A Late Neolithic henge monument site excavated in 1969. Finds include faunal remains from the north entrance (primary silt of the ditch) and artefacts (e g. grooved ware). The faunal collection is held at the DM. According to Castleden (1992), the site was probably occupied by c. 5,200 BP, but the henge was constructed afterwards (c. 4,400 BP). Radiocarbon dating (Appendix 1) supports a Late Neolithic age range (c. 3,900-3,500 BP) for the enclosure ditch of the site.

Horse remains are present from Marden Henge and the author has studied the only available specimen (a partial femur) at the DM. It is uncertain whether this bone represents the complete collection of Marden horse because according to Harcourt (1971a), 8 specimens of horse and red deer were found in total. Also, the exact provenance (probably within the ditch) of this femur is not known with any certainty. The associated mammalian faunal remains include (all probably from the ditch): red deer, cattle, pig, sheep, and aurochs (possibly the larger *Bos* sp.). Furthermore, the author noticed that the remains had two different preservation types: reddish/brown (the horse and the larger bovid) and white (the smaller bovid).

Millbarrow Chambered Tomb (=Winterbourne Monkton G17a), near Avebury, Wiltshire [SU 095 722], References: Hedges *et al.* (1992); Noddle (1994); Whittle (1994); Whittle (pers. comm.)

A Neolithic chambered tomb located in the Upper Kennet Valley, excavated most recently by Whittle (1994) who considers this site to have provided "the first well-documented information for the Neolithic period" for the region north of Windmill Hill. Finds include faunal remains which are currently held with the excavator, although they are destined for the DM (Whittle, pers. comm.). Subsequent radiocarbon dating for human and faunal remains has produced dates (Appendix 1) which lie within a Neolithic range (c. 4,900-4,500 BP).

Horse remains (two cheek teeth and one Phal I) are present from Millbarrow; however, Whittle (1994) notes that no horse specimens were recovered from the ditches, and that those from other features (e g Trench D and the chamber) are "not certainly Neolithic". Furthermore, Whittle (pers. comm) believes that if the horse material has come from the "disturbance destruction phase" it may even date to a more recent period (i e. very late Holocene). Due to time constraints, the present author was

unable personally to study and date these specimens. In addition to horse, the mammalian faunal assemblage includes bovid (*Bos* sp.), pig, sheep/goat, red deer, fox, and rodents.

Milton Lilbourne (Barrows I-V), Wiltshire, References: Ashbee (1986); Grigson (1986); Grigson (pers. comm.)

Neolithic and Early Bronze Age barrows (I-V) excavated by Ashbee (1986) yielding evidence for the Wessex culture. Finds from the barrow deposits (occupation debris) include faunal remains which were derived mainly from the loam cores of barrows IV and V; however, some remains were found in barrows I-III as well as the "ancient soils" (i.e. deposits not older than the Early Neolithic) which underlay the barrow core deposits. The faunal collection is held at the DM. Subsequent radiocarbon dating has produced dates which lie within the Late Neolithic/Early Bronze Age (c. 3,800-3,400 BP) for the site (Ashbee, 1986).

Horse remains are present only from barrows I, II, III and V and the author has examined all the available specimens (one Phal I, five cheek teeth). Based on their small size, Grigson (1986) considers these remains (*E. caballus*) to represent "ponies" rather than "horses". For a discussion of the differences between horses and ponies see chapter 1. In addition to horse/"pony", the faunal assemblage includes (from Barrows I-V and the ancient soils): cattle, pig, sheep/goat, red deer, roe deer, and dog.

Overton Hill (The Sanctuary), near Avebury, Wiltshire, References: Cunnington (1931); Jackson (1931, 1943a); Grigson (1966); Neil (1977)

A Neolithic henge site investigated by Cunnington (1931). Finds include faunal remains and artefacts (e.g. pottery). The faunal collection is held at the NHM. Horse is present from 'The Sanctuary' (from PH E2: 10ft. ring) and the author has studied the only available specimen (a complete MCIII: ARC 1970.3148, "treated" with PVA) at the NHM. According to Jackson (1931,1943a) this "small" horse, which he designates as an "*E. agilis*-type" (see chapter 2), was associated with the remains of ox ("not *Bos longifrons*"), pig, and dog Additional mammalian faunal remains in the assemblage held at the NHM include red fox and red deer.

Potterne, Wiltshire, References: Gingell and Lawson (1985); Pearson (1993)

A Late Bronze Age open settlement site in the Wessex River Valley which was excavated by Gingell and Lawson in 1984. According to Pearson (1993), finds from the "huge" midden supposedly included "thousands of tons of horse dung". Gingell and Lawson (1985), however, make no mention of horse dung or horse remains having been found.

Snail Down (Sites I-XXII), Everleigh, Wiltshire [(SU 220 520)], References: Thomas and Thomas (1955); Annable (1958); Neil (1977); Grigson (1981a); Barrett *et al.* (1991); Hedges *et al.* (1995)

Sites on the Wiltshire Downs excavated by N. Thomas in 1953-58 which consist of Beaker settlements and an Early Bronze Age round barrow cemetery. Finds include faunal remains and artefacts as well as a collared urn burial dated to the Early Bronze Age (c. 3,500 BP: Appendix 1) which may or may not be associated with the faunal remains (Grigson, 1981a). The faunal collection is held at the NHM. Further radiocarbon dating (Appendix 1) for charcoal and human samples from Sites XIV, XVII and XXII again range within the Bronze Age (c. 3,600-3,500 BP).

Horse remains are present from Snail Down (Sites I-III and VI/VIII) and the author has studied the available specimens (mainly postcranials: all "treated" with PVA) in detail at the NHM. In addition to horse, the mammalian faunal assemblage includes dog, pig, ox, sheep/goat, aurochs, red deer, and roe deer as well as Rodentia and Insectivora.

Stonehenge, Wiltshire [SU 123 422], References: Gowland (1902); Hawley (1920-21, 1923-26, 1928); Jackson (1935); Neil (1977); Serjeantson (1995)

The famous henge monument which has been excavated many times and by many different people (Serjeantson, 1995). The present author is primarily concerned with the older excavations by Gowland in 1901 and by Hawley in 1920-26, both of which yielded faunal remains from Neolithic/Early Bronze Age and later contexts. The faunal collections are held at the SSWM. Recent radiocarbon dating of faunal samples has produced several reliable dates (Appendix 1) for the site which range mainly within the Neolithic and Beaker (c. 5,400-3,500 BP) periods.

Horse remains (postcranials and teeth) are present at Stonehenge and the author has examined a small proportion of both the Gowland and Hawley collections in detail

at the SSWM. According to Jackson (1935), three horse specimens (included in the present study) were derived from the 'upper or humus layers' of a ditch (Ditch IV, level 2) which also contained Neolithic to later Holocene finds. Also, Serjeantson (1995) notes the presence of horse remains in the "Stonehenge and later layers" (probably dating to the post-Bronze Age); however, more significantly, she notes their absence from older deposits (i e. the "primary and secondary fill of the Ditch" and Jackson's 'lower or silt layer'). The additional mammalian faunal remains include domestic pig, wild pig, cattle, aurochs, wolf, red fox, dog, red deer, sheep, and roe deer.

Thorny Down, Winterbourne Gunner, Wiltshire [SU 203 338], References: Jackson (1937a); Stone (1937, 1941); Neil (1977)

A Late Bronze Age habitation (settlement) site excavated in 1936. Finds include faunal remains and artefacts (e.g. Late Bronze Age [Deverel-Rimbury] pottery). The faunal collection is held at the NHM. Horse is present from the "Dwelling" of the site in the form of one cheek tooth (ARC 1970.3125: "treated" with PVA) which is possibly intrusive (Neil, 1977). Despite this, the author has studied this specimen. Additional faunal remains (all from the ditch) include ox, pig, and sheep

West Kennet Long Barrow, Wiltshire [SU 104 677], References: Piggott (1962); Neil (1977); J. Herman (pers. comm.)

A Neolithic chambered long barrow site excavated by Piggott in 1955-56 The finds include faunal remains (some humanly modified) as well as artefacts (e.g. Neolithic and Beaker pottery, flints). The bulk of the faunal collection is held at the NMS, Edinburgh; however, a small amount of material is conserved at the DM. Radiocarbon dating of faunal samples has yielded dates (Appendix 1) which lie within the Mid-Late Neolithic (c. 4,800-4,700 BP) and the Early Bronze Age (c. 3,800-3,600 BP). Horse (one tooth) is supposedly present from layer 2 of the north-west chamber ("i e. not the primary fill", according to Neil (1977)) and is conserved at the NMS (J Herman, pers. comm). Due to time constraints, the present author was unable to study this specimen; however, on a recent visit to the DM, it was evident that no horse remains are held there Additional faunal remains include ox, sheep/goat, pig, dog, red deer, and small mammals.

West Overton, Kennet Valley, Wiltshire [SU 4113 5686], References: Hedges *et al.* (1987)

An open site from which investigations of deposits in the valley of the River Kennet yielded faunal as well as environmental remains (Hedges *et al.*, 1987). Radiocarbon dating of both faunal (non-horse) and environmental samples has produced dates (Appendix 1) which range within two separate Holocene periods, one early (c. 8,400-8,300 BP) and the other later (c. 3,900-3,000 BP).

Horse remains are present from West Overton and one specimen has been shown to date to the later Holocene (c. 2,500 BP: Appendix 1). Additional faunal remains include domestic cattle, aurochs and wild boar.

Wilsford Shaft, Normanton Down, Wiltshire, References: Ashbee (1963, 1966); Megaw and Simpson (1984); Hedges *et al.* (1988: AM7)

A Bronze Age ritual site excavated by Ashbee (1963). Finds include faunal remains as well as wooden finds (e.g. wooden stave-built tubs) (Megaw and Simpson, 1984). Radiocarbon dates for these wooden finds lie within the Late Bronze Age (c. 3,300 BP). Horse is present from the site and the most recent radiocarbon dating for these remains has yielded dates (Appendix 1) within the Early Iron Age (c. 2,500-2,400 BP).

Windmill Hill, Wiltshire [SU 087 713], References: Smith (1965); Jope (1965); Grigson (1981b); Hedges *et al.* (1992); C. Conybeare (pers. comm.); C. Grigson (pers comm.)

A Neolithic causewayed camp (enclosure) excavated in 1925-39 (by Alexander Keiller) and 1957-58 and most recently in 1988. Finds from all excavation periods include faunal remains most of which are held at the Alexander Keiller Museum, Avebury. Both conventional and accelerator radiocarbon dating of human and faunal remains have yielded dates (Appendix 1) which lie within the Neolithic (c. 4,900-3,500 BP).

According to Jope (1965) and contrary to Jackson (1943), horse remains (two sterna) are present from Windmill Hill (within primary levels of enclosure ditches) However, Grigson (pers. comm.) believes these identifications of horse sterna to be uncertain and perhaps of a dubious nature. Unfortunately, C. Conybeare (pers. comm) of the Alexander Keiller Museum, Avebury could not locate the supposed horse from

Windmill Hill in her collections. Based on the above evidence, it appears that in addition to their whereabouts currently being unknown, these remains may have been misidentified as horse originally. The additional mammalian faunal remains include ox, pig, ?wild pig, red deer, fox, badger, hare, cat, dog, sheep/goat and aurochs.

Woodhenge, Durrington, Wiltshire [SU 1506 4338], References: Cunnington (1929); Jackson (1943a); Grigson (1966); Neil (1977)

A Neolithic henge monument site which yielded faunal remains. The faunal collection is held at the DM. Radiocarbon dating of faunal remains has produced dates (Appendix 1) which lie within the Late Neolithic (c. 3,800-3,700 BP). Horse is supposedly present from the site and according to Jackson (1943a) a specimen (fragmentary mandibular symphysis) was found in association with "long-horned" ox, sheep/goat, pig and dog. However, on a recent visit to the DM, the author was unable to locate the horse material. Furthermore, because no horse was mentioned by Cunnington (1929) in the original excavation report and Neil (1977) too could not trace the horse at the DM, he regards the identification of horse from this site as "dubious". Based on the evidence (or lack of it), the present author is inclined to agree with this suggestion. The faunal assemblage is thought to include ox, pig, sheep, dog, deer, fox, cat and weasel.

Woolwich Green Gravel Pit (?Theale Gravel Pit), Theale, Berkshire [SU 639 706], References: Cooper and Jeffrey (1996: NHM unpubl.), A. Currant (pers. comm.)

A gravel pit site located in the flood plain of the River Kennet excavated most recently by Currant, Cooper and Jeffrey on behalf of the NHM in 1994-96. A stratigraphic sequence was determined and consists of five well-defined Quaternary layers overlying Tertiary deposits With respect to the Quaternary layers, finds from the tufaceous marl deposit which overlies river terrace gravels include a small mammalian faunal assemblage as well as abundant remains of freshwater and terrestrial molluscs. No evidence of associated archaeology was found. The finds are held at the NHM; however, a small collection of faunal remains from a presumably earlier investigation of "Theale Gravel Pit" is held at the RMAG

Horse remains are present from Woolwich Green and the author has studied all the available specimens (two MTIII and one tibia) at the NHM and RMAG. One complete MTIII (unregistered) was found stratified within the tufaceous marl deposit

mentioned above; however, the partial tibia (unregistered) was not found "*in situ*", but was found somewhere near the pit (A. Currant, pers. comm.). The partial MTIII (147:86/3 5068) studied by the author at RMAG was recorded as being found "lying on the base of gravel" in association with a beaver bone. All three bones appear to be highly mineralised. One specimen (unregistered MTIII) was chosen for radiocarbon dating (table 4.5) and unexpectedly it dates to the later Holocene (c. 1,550 BP). The additional mammalian fauna from the tufaceous deposit includes "small" cow, cervid (probably red deer), and short-tailed vole.

Region 10:

Runnymede Bridge, Egham, Surrey, References: Longley (1980); Ambers, Matthews and Bowman (1991); Done (1991); Needham (1991)

A Late Bronze Age waterfront settlement site excavated by Needham in 1976 and 1978. Finds include abundant faunal remains mainly from the Late Bronze Age deposits; however, some animal remains were recovered from Middle and Late Neolithic deposits. Additional finds include artefacts such as possible horse trappings (e.g. antler cheek pieces from harnesses) (Longley, 1980). The faunal collection is conserved at the BMFH. Radiocarbon dating of a bone sample has yielded a date (Appendix 1) within the middle Holocene or Neolithic (c. 4,600 BP).

Horse remains are present at Runnymede Bridge from Late Bronze Age contexts only and the author has studied a proportion (from Areas 6, 14, 16E, 20-22, 26, and 30-31) of these specimens in detail at the BMFH. A notable discovery (Done, 1991) consists of a possible ritual burial of a male horse (an almost complete skeleton from Area 6, Pit F6: layers 5 and 6). Done (1991) also notes the unusual wear on this horse s maxillary incisors which she ascribes to either the behavioural stereotypie called "crib-biting" or to some form of wood/stable chewing. Furthermore, Done (1991) describes horse bones which show evidence of pathology (i.e. extosis and ankylosis) as well as human modification (i.e. butchery and burning). Subsequent radiocarbon dating (Appendix 1) of the Pit F6 horse has produced a date which lies within the Late Bronze Age/Early Iron Age (c. 2,800 BP). In addition to horse, the Late Bronze Age mammalian assemblage includes ox, sheep goat, pig, dog, red deer, roe deer, water vole and a small mustelid

Minnis Bay, Birchington, Kent, References: Worsfold (1943); Jackson (1943b); Neil (1977); Megaw and Simpson (1984)

A Late Bronze Age/Early Iron Age settlement site discovered in 1938 and excavated by Worsfold in the 1938-40 and by Powell-Cotton in 1955-56. According to Neil (1977) both the Worsfold and Powell-Cotton excavations yielded horse remains. The incomplete faunal collection (Worsfold) is held at the NHM. The present author has studied the available horse specimens (two MTIII and two innominate bones: all ARC 1970.3138 and "treated" with PVA) in detail at the NHM. The additional mammalian remains held at the NHM include human, cattle and sheep.

Offham, Maidstone, Kent, References: Gillespie *et al.* (1985)

Excavations at this quarry site yielded horse remains thought to date to the Late Pleistocene; however, radiocarbon dating supports an Iron Age date (c. 2,300 BP: Appendix 1) for the horse from this site.

St. Lawrence College, Ramsgate, Kent, References: Jackson (1943c); Neil (1977)

A Middle to Late Bronze Age occupation site. Finds include faunal remains (as occupation debris) from the chalk rubble and artefacts (e.g. a Deverel-Rimbury urn) from a pit. The faunal collection is held at the NHM. Horse remains are present from the site and the author has examined all the available specimens (three cheek teeth: all ARC 1970.3098, all "treated"). Additional faunal remains include ox.

Region 12:

Quanterness, Orkney, Scotland [HY 418 130], References: Henshall (1963); Renfrew *et al.* (1976); Neil (1977), Clutton-Brock (1979); Hedges *et al.* (1995), Clutton-Brock (pers. comm.)

A Neolithic chambered round cairn (or tomb) site on the Orkney mainland most recently excavated by Renfrew in 1972-74. Finds include faunal remains and artefacts (including grooved ware sherds) dating to both the Neolithic and the Iron Age. The faunal collection is held at the NHM. Subsequent radiocarbon dates (Appendix 1) for the site include those within the Neolithic (c. 4,500-4,100 BP) and Iron Age (c. 2,600-2,000 BP).

Horse remains are present from this site and the author has studied all the available specimens (one astragalus and four deciduous cheek teeth: ARC 1976.5091)

at the NHM. One tooth, from the upper disturbed layers of area III in the main chamber of the tomb, has been radiocarbon dated (Appendix 1) to the later Holocene (c. 900 BP) (Hedges *et al.*, 1995). In addition to horse, the mammalian faunal remains include sheep, ox, red deer, pig, otter, and red fox.

Skara Brae, Orkney, Scotland [HY 231 188], References: Childe (1931), Shotton *et al.* (1975); Clarke (1976); Hedges *et al.* (1995); Clutton-Brock (pers. comm.)

A Neolithic settlement site on the Orkney mainland excavated most recently by Clarke in 1972-73 and 1977. Radiocarbon dates for faunal samples (Appendix 1) lie within the Late Neolithic/Early Bronze Age (c. 4,300-3,800 BP). Horse remains are present from the site and one tooth, from a supposedly secure Neolithic context, was radiocarbon dated This date (Appendix 1) unexpectedly lies within the later Holocene (c. 1,400 BP). Additional mammalian faunal remains include sheep, cattle, deer (cervid), pig, and whale.

4.3.3 Gazetteer of selected sites including a survey of their horse remains and existing dating evidence: Ireland

Selected Irish sites with horse material: Mid-Midlandian (i.e. Middle Devensian) to Holocene

Region 15:

Curran Point, Larne, Co. Antrim, N. Ireland [IG D413023], References: Doughty (1969); Woodman *et al.* (1997)

A raised beach deposit which yielded horse remains (two associated cheek teeth: K1363 4) within supposedly "undisturbed" gravels thought to date to early-middle Holocene (c. 6,000-5,000 BP). One of these teeth has been radiocarbon dated and its date (Appendix 1) lies within the later Holocene (c. 100 BP) instead of the expected earlier period.

Sydenham Station Beach Site, Belfast Borough, Co. Down, N. Ireland [IG J370750], References: Patterson (1892); Woodman (1978); Woodman *et al.* (1997)

An "intertidal beach" deposit at Belfast Lough originally investigated by Patterson in the late 19th century. Finds from the site include mammalian remains in

association with later Mesolithic artefacts. However, newly obtained radiocarbon dates (Appendix 1) for the fauna appear to postdate the Mesolithic period (i.e. later Post Glacial). Horse remains are present from the site and one specimen produced a Recent date (c. 100 BP) (Appendix 1), whereas the 'associated' red deer yielded an older, yet still Post Glacial, date (c. 2,000 BP) (Appendix 1). In addition to horse and red deer, the other associated faunal remains include wild pig and bovid (*Bos* sp.) (Woodman, 1978).

Drumquin, Dunnoree Hill, Co. Tyrone, N. Ireland [IG H310720], References: Woodman *et al.* (1997)

According to Woodman *et al.* (1997), a horse tooth was found in a deposit (till) which was possibly pre-Last Glacial in age. However, subsequent radiocarbon dating (Appendix 1) of this specimen instead supports a later Holocene (c. 600 BP) age for the horse from Drumquin.

Region 16:

Plunkett Cave (Kesh Corran Cave Complex: cave P), Co. Sligo, Ireland [IG G710130], References: Scharff *et al.* (1903); Gwynn *et al.* (1940); Neil (1977); Woodman *et al.* (1997)

One of many cave sites (A-O) on Keshcorran Hill excavated by Scharff in 1899. Two deposits (Strata 1 and 2: brown earth and clay) were identified within the cave deposits and yielded mixed Pleistocene/Holocene mammalian remains. Several radiocarbon dates (Appendix 1) for the non-horse fauna of Plunkett Cave are available and they range within both the Late Glacial (c. 12,200-11,200 BP) and later Post Glacial (c. 600 BP) periods. Additionally, dates (Appendix 1) for fauna from the nearby Coffey Cave (J) and Cave N range within different zones of the Late Glacial (c. 10,100 BP) and Post Glacial (c. 7,700 BP) periods.

Horse remains are present from this cave site and one specimen from the mouth of the cave has been radiocarbon dated (Woodman *et al.*, 1997). This date (Appendix 1) lies within the later Post Glacial (i.e. early Medieval period: c. 1,600 BP), rather than the Late Glacial range The present author has examined one undated horse specimen (a very small Phal I. M.8658) from the "upper stratum" of Plunkett Cave conserved at the NHM. In addition to horse, the mammalian faunal remains from Plunkett Cave include brown bear, red deer, wolf, and arctic hare, while stoat and

arctic lemming (both dated: see above) were found in Coffey Cave and Cave N, respectively.

Dún Aonghasa, Inis Mór, Co. Galway, Ireland, References: McCormick (1994); F. McCormick (pers. comm)

Recent excavations at this Late Bronze Age site, a stone fort located on the Aran Islands, yielded abundant faunal remains. Radiocarbon dating of remains has produced dates which range within the first half of the first millennium BC (= c. 2,950-2,450 BP). A provisional list of the mammalian faunal remains from Dún Aonghasa includes horse, in addition to cattle, pig, sheep/goat, red deer and seal.

Lough Shad, Carrowbaun TD, Co. Roscommon, Ireland [IG M832760], References: Woodman *et al.* (1997)

Supposedly ancient horse remains were found at this site "in the base of sandy gravel in the bank of a stream" (Woodman *et al.*, 1997). A bone has been radiocarbon dated (Appendix 1) and is now shown to be of later Holocene age (c. 500 BP) rather than that of the Pleistocene or early Holocene.

Region 17:

Ballyveelish (F19 and F67), Co. Kildare, Ireland, References: McCormick (1994); F. McCormick (pers. comm)

Excavations at this later Bronze Age habitation site yielded faunal remains from a rectangular ditch. Radiocarbon dates (uncalibrated) place the deposits within the ninth to seventh centuries BC (= c. 2,850-2,550 BP). Horse remains are present from Ballyveelish in addition to those of cattle, pig, sheep/goat, dog, and red deer.

Haughey's Fort, Co. Meath, Ireland, References: McCormick (1991, 1994); F. McCormick (pers. comm)

Excavations at this Late Bronze Age site, a fort located near King's Stables, yielded faunal remains thought to be food refuse from a waterlogged ditch which dates to the eleventh century BC (= c. 3,050-2,950 BP) Horse remains are present from Haughey's Fort in addition to those of cattle, pig, sheep/goat, dog, red deer, and fox.

King's Stables, Co. Meath, Ireland, References: McCormick (1994); F. McCormick (pers. comm.)

Excavations at this Late Bronze Age site, a ritual pond located near Haughey's Fort, yielded a small faunal assemblage assumed to be food refuse. The site is thought to date, like Haughey's Fort, to the earlier first millennium BC (= c. 3,000-2,900 BP). Horse remains are present from King's Stables in addition to cattle, pig, sheep/goat, dog, red deer and badger.

Newgrange, Co. Meath, Ireland, References: O'Kelly (1964, 1968, 1972); van Wijngaarden-Bakker (1974, 1986); McCormick (1994)

An immensely important Late Neolithic/Beaker settlement site excavated by O'Kelly during two main seasons: 1962-65 and 1966-69; however, according to van Wijngaarden-Bakker (1974), further excavations continued through to 1973. During the two main periods mentioned, excavations within three "units" yielded an abundance of faunal remains as well as Late Neolithic/Beaker artefacts (e.g. flints and pottery). McCormick (1994) considers the animal remains from the Beaker levels at this site to be "the single largest prehistoric assemblage" in Ireland. The three "units" mentioned above which yielded animal remains comprise: 1) the "Central Unit" which consists of levels within two horizons (A: old ground level [OGL] and the granite/quartz and earth/stone layers, and B: pits, trenches and ditches [some Medieval and Recent]), 2) the "Western Unit" consisting of two "sub-units" (Under the yellow clay bank [YCB] and OGL and the granite/quartz layer); and 3) The "Eastern Unit" consisting of two "sub-units" (OGL and Beaker pits of the multiple arc). Subsequent radiocarbon dating of associated charcoal from the settlement area has produced dates (Appendix 1) which lie within the Late Neolithic/Beaker period (c. 4,000-3,900 BP).

Horse remains (c. 150 fragments including teeth and postcranials) are present from the levels of all "units" of the Newgrange settlement site. However, van Wijngaarden-Bakker (1986) highlights the "absence of horse remains in the stratigraphically older deposits" (i e the "under YCB" and "Beaker pits" horizons within the West and East Units, respectively). It must be stressed that no horse remains have, as yet, been radiocarbon dated. In addition to horse, the Late Neolithic/Beaker mammalian faunal assemblage from Newgrange includes cattle, pig, sheep/goat, dog, red deer, fox, "mountain" hare (*Lepus* cf *timidus*), wildcat, and brown bear.

Region 18:

Shandon Cave, near Dungarvan, Co. Waterford, Ireland [IG X292590], References: Brenan and Carte (1859); Adams (1876); Ball (1885); Woodman *et al.* (1997)

A cave site first investigated in the 1850's by Brenan and then by Adams in 1875. Adams determined a stratigraphic sequence for the cave deposits which consisted of five layers (Layers A-E: top to base). Finds from both investigations include abundant Pleistocene mammalian remains from Layers B (stalagmite) and C (breccia); however, some Recent faunal remains (e g. red deer, birds, caprids and rabbits) were also found in the upper deposits (A-C) of Cullen's Chamber. A recent radiocarbon dating project (Woodman *et al.*, 1997) has yielded dates (Appendix 1) which support a Middle Midlandian (= Middle Devensian) age (c. 32,400-26,100 BP) for the assemblage.

Horse remains (postcranial elements only) from the Brenan excavations are present from Shandon Cave, and according to Woodman *et al.* (1997), at least six individuals are represented. One radiocarbon determination (Appendix 1) obtained for horse lies within the Middle Midlandian age range mentioned above, thus supporting the previously disputed existence of horse in Ireland during the Pleistocene. This issue will be dealt with more fully in section 4.5.2 below. In addition to horse, the Pleistocene mammalian remains include mammoth, reindeer, brown bear, red deer, wolf, arctic fox, and arctic hare.

Bat Cave (Edenvale Complex: Newhall/Barntick group), Edenvale, Co. Clare, Ireland [IG R310740], References: Scharff *et al.* (1906); Woodman *et al.* (1997)

A cave site near Ballybeg Lough first investigated in 1902-04. With respect to all the caves in the complex, cave deposits were supposedly separated into two levels: upper and lower (Woodman *et al.*, 1997) Finds include a mixed assemblage of human and mammalian faunal remains as well as Palaeolithic to early Medieval artefacts. Radiocarbon dates (Appendix 1) for faunal remains from several of the Edenvale caves range within both the Late Glacial (c. 11,800-10,000 BP) and later Post Glacial (c. 2,300-1,700 BP) periods.

Horse remains are present from Bat Cave (2nd stratum) and one specimen (Appendix 1) dates to within the later Post Glacial range mentioned above The present author has personally examined two other horse specimens (one very small adult Phal I) from "Newhall/Edenvale Caves" held at the BGSM, Keyworth. In addition to horse,

the mixed faunal assemblage from the caves of the Edenvale Complex includes rabbit, domestic cat, sheep, cattle, red deer, wolf, reindeer, giant deer, and arctic lemming (Woodman *et al.*, 1997).

Killuragh Cave, Cappamore, Co. Limerick, Ireland [IG R778497], References: Woodman *et al.* (1997); P. Woodman (pers. comm)

A cave site excavated by O'Shaughnessy in 1993 and most recently by Woodman in 1996. The cave deposits yielded faunal remains of mixed age (Late Pleistocene and Holocene) as well as Early Mesolithic and Neolithic artefacts. Additionally, Neolithic burials were discovered. According to Woodman *et al.* (1997), the cave deposits here are disturbed. A radiocarbon project (Woodman *et al.*, 1997) to date faunal remains from Irish sites has produced dates (Appendix 1) which lie within both the Late Glacial (c. 11,500 BP) and later Holocene (c. 1,000 BP) periods.

Horse remains are present from Killuragh Cave and the author has had the opportunity to briefly study one specimen (a sacrum) which has now been radiocarbon dated as part of the current study in collaboration with P. Woodman. According to P. Woodman (pers. comm.), this specimen (together with a human jaw) came from a shallow pit in Cave 1 which was stratified below an artefactual (i.e. microlith) layer. This new date (table 4.5) lies within the middle-later Holocene or later Bronze Age (c. 3,000 BP); however, it is from an earlier period than the one noted above. In addition to horse, the mixed faunal assemblage includes human, giant deer, and red deer.

4.3.4 Discussion of selected sites without horse material: Britain and Ireland

Selected sites in Britain and Ireland are discussed below in order to highlight the fact that some assemblages contain either no horse material in relevant Late Pleistocene/Holocene levels or no horse material in any level. Later in this chapter (sections 4.5, 4.6), geographical and chronological comparisons will be made between the non-horse sites and those with horse. Care was taken to note only the sites with large or medium-sized faunal collections which consist of a wide-range of mammalian species in order to ensure that the absence of horse at these sites is significant The majority of sites mentioned below and in the discussion (see *Overview and Conclusions* in section 4 5 2) were discovered via a literature survey; however, a few sites (e g. Cherhill and Windy Knoll) were investigated personally by the author (i.e the author examined the relevant collections)

Four periods within the Late Pleistocene/Holocene can be highlighted with regard to the absence of horse at particular sites in Britain: 1) the Early to Middle Devensian, 2) the Late Glacial, 3) the early Post Glacial, and 4) the middle Holocene (or middle Post Glacial). It is necessary to mention the lack of horse at sites which date to the Early-Middle Devensian because of the transitional nature of the episode. According to Currant and Jacobi (1997), faunal assemblages from sites of this period represent an interlude of lower species diversity compared to the Middle Devensian and date between the 'Last Interglacial' and the Middle Devensian. The typical large mammal assemblage from sites such as Banwell Bone Cave, Somerset (Rutter, 1829; Currant and Jacobi, 1997), Bosco's Den, W. Glamorgan (Murchison, 1868; Grigson, 1978; David, 1991), and Windy Knoll Cave, Derbyshire (Dawkins, 1877b; Grigson, 1978) includes bison, reindeer, wolf, wolverine, arctic hare, and a large type of brown bear. Because horses are conspicuously absent from sites such as those mentioned above, this indicates that the horses of the following episode in Britain (i.e. the Mid-Late Devensian) date from an immigration after the period of absence. This point is pivotal because these Middle Devensian immigrants as well as those of the Late Glacial are the substance of the current work.

Interestingly, a few Late Glacial sites in Britain exist which either lack horse remains within their Late Glacial deposits or lack horse altogether. Sites such as Broken Cavern, Devon (A. Roberts, pers. comm); Kinsey Cave, N. Yorkshire (Jackson, 1931a; Jackson and Mattinson, 1932; Campbell, 1977; Grigson, 1978); and Dowel Cave, Derbyshire (Bramwell, 1959, 1960, Campbell, 1977) have all yielded Late Glacial faunal assemblages (previously radiocarbon-dated: see Appendix 1) which exclude horse. The significance of these examples of absence will be discussed in detail later in this chapter (see *Overview and Conclusions* in section 4 5.2).

There are far more Post Glacial (mainly middle Post Glacial) sites in Britain which exclude horse. One significant, well-known early Post Glacial site without horse must be mentioned. Star Carr (or Flixton site IV), N. Yorkshire (Clark, 1954, Schadla-Hall, 1987; Legge and Rowley-Conwy, 1988) is an immensely important open site situated in the Vale of Pickering close to Seamer Carr and Flixton site II which have been mentioned in detail above (see gazetteer in section 4 3.2) Star Carr was excavated by Clark in the 1950's and the finds include abundant mammalian remains as well as Early Mesolithic artefacts, some of which include bone/antler points, elk antler mattocks and stag (red deer) antler frontlets The assemblage discovered at the

site has been reliably dated to the Early Mesolithic (late [pollen] zone IV to zone V) using faunal, artefactual, environmental (e g. pollen analysis) and radiometric evidence. Legge and Rowley-Conwy (1988) note that radiocarbon dates (Appendix 1) average c. 9,488 BP. Significantly, no horse remains are present from Star Carr even though early Holocene (i.e. Early Mesolithic) horses are present at the nearby open sites of Seamer Carr and Flixton site II. See section 4.5.2 for further consideration of this important issue.

As mentioned above, a significant number of middle Post Glacial sites are without horse These sites have yielded large or medium-sized faunal assemblages which date to the Mesolithic and Neolithic. It is beyond the scope of this project to list all the sites lacking horse which pertain to this middle Holocene period because there are so many; however, it is practicable to highlight some important examples. For instance, previous radiocarbon dating (Appendix 1) confirms that non-horse deposits at sites such as Westward Ho!, Devon (Rankine, 1961; Churchill and Wymer, 1965; Grigson, 1978, Megaw and Simpson, 1984), Blashenwell Farm, Dorset (Clark, 1938; Rankine, 1961, Grigson, 1978; Preece, 1980), Hambledon Hill, Dorset (Selkirk, 1975; Legge, 1981; T. Legge, pers. comm.), and Cherhill, Wiltshire (Grigson, 1978; Evans and Smith, 1983) date to the Mesolithic/Neolithic (e g. Later Boreal: zone VI; Atlantic: zone VIIa; early Sub-Boreal: zone VIIb). A further examination of the significance of the absence of horse at these sites and others will be given in section 4.5.2 (see *Overview and Conclusions*).

Finally, it is necessary to mention some Late Pleistocene/Holocene sites without horse which are located in Ireland. In particular, horse remains appear to be absent from a large number of deposits containing faunal assemblages which date to the Mid-Midlandian (or Mid-Devensian) as well as all deposits dating to the Woodgrange (or Windermere) Interstadial. Ballynamintra Cave, Co. Waterford (Adams *et al.*, 1881; Ball, 1885; Jackson, 1953; Woodman *et al.*, 1997), Kilgreany Cave, Co. Waterford (Tratman, 1929; Movius, 1935, Jackson, 1953; Woodman *et al.*, 1997), and Castlepook Cave, Co. Cork (Ussher, 1881; Scharff *et al.*, 1918; Jackson, 1953; Woodman *et al.*, 1997) are three such sites which have yielded non-horse faunal assemblages within deposits dating (Appendix 1) to one or more of the three key periods (i e Mid-Devensian, Late Glacial, and Post Glacial). Interestingly, for two of the three sites mentioned above (i.e. Ballynamintra and Castlepook) horse remains are available, but only in the upper (Holocene) deposits and in association with mainly

domestic animals. For a more in-depth discussion regarding the chronological distribution (including both presence and absence of the horse) in Ireland during the Late Pleistocene/Holocene see section 4 5.2

4.4 Review of relevant Late Pleistocene and Holocene sites in continental Europe

4.4.1 Introduction

The main aim of this section is to highlight the study of faunal remains from palaeontological and archaeological deposits of cave and open sites in Europe excluding Britain and Ireland (i.e. continental Europe). Because a survey of European Pleistocene/Holocene sites and their fauna would be prohibitive, it is necessary, as part of the current project, to emphasise only the key investigations which have been undertaken in the study of latest Pleistocene to Holocene (i.e. Mid-Late Weichselian to middle Holocene) European horses. Many palaeontologists and archaeozoologists will be mentioned in the present study; however, it is evident that only a handful (e.g. A. Forsten, V. Eisenmann, H.-P. Uerpmann, M. Levine) have stressed the importance of chronological (e.g. the use of well-dated sites/material), ecological (e.g. effects of climate and vegetation change), morphological (e.g. size change through time) and geographical (e.g. distribution of populations) considerations in their direct investigations of the Late Pleistocene/Holocene wild and early domestic horses of Europe. Since the authors mentioned above have demonstrated that it is good practice to utilise techniques such as direct specimen measurement and accelerator radiocarbon dating, it is necessary to highlight their use in the current survey of British and Irish horses of this period. It must be emphasised again, however, that this directory is by no means definitive, and must only serve as a list of key sites whose horse finds can be compared directly with material from British and Irish sites

4 4 2 Gazetteer of selected sites including a survey of their horse remains and existing dating evidence: continental north-west Europe

Key sites with horse material: Mid-Late Weichselian (including Late Glacial) to Holocene

GERMANY:

Andernach-Martinsberg (An1 and An2), Rhineland-Palatinate, Germany, References: Turner (1990, 1991); Street *et al.* (1994); Bosinski *et al.* (1995); Street (1995a); M. Street (pers comm.)

An open site located in the Neuwied Basin along the Rhine and is in close proximity to the site of Gönnersdorf. Andernach-Martinsberg was originally excavated by H. Schaaffhausen in 1883 and most recently (Street, 1995a) in 1979-83. Finds from these excavations include faunal remains (many humanly modified) and artefacts which are indicative of two periods of Late Glacial occupation at the site: 1) An1- a Magdalenian (i.e. older occupation) assemblage and 2) An2- a Federmessergruppen (i.e. younger occupation) assemblage. The faunal collection is held at the RGZSM, Neuwied. Subsequent radiocarbon dating supports this segregation within the Late Glacial having produced both Bølling and Allerød Interstadial dates (c. 13,200-12,300 BP and c. 12,000-11,300 BP, respectively) (Appendix 1).

Horse remains are definitely present within the Magdalenian assemblage and possibly within the Federmessergruppen one (i.e. they are of uncertain context) at Andernach (An1 and An2, respectively); and the author has examined a proportion of this material (selected teeth and postcranials) at the RGZSM, Neuwied. Previous radiocarbon dating of horse remains has yielded dates (Appendix 1) which lie within the earlier Late Glacial (or Bølling Interstadial) period mentioned above. In addition to horse, the Magdalenian mammalian faunal assemblage includes mammoth, red deer, reindeer, arctic fox, weasel, arctic hare, steppe pika, collared lemming, and narrow-skulled vole. On the other hand, the Federmessergruppen (or Allerød Interstadial) mammalian faunal assemblage includes chamois, red deer, elk, beaver, wood mouse, hamster (*Cricetus* sp), bank vole, water vole, voles (*Microtus* spp.), and possibly aurochs Lynx can also be included amongst the fauna at Andernach; however, Turner (1990) notes that it is not known to which assemblage (i e Magdalenian or Allerød) it belongs.

Gönnersdorf, Rhineland-Palatinate, Germany, References: Poplin (1976), Turner (1990, 1991); Street *et al.* (1994); Bosinski *et al.* (1995); Bosinski (1979, 1995); M. Street (pers. comm.)

An open site located in the Neuwied Basin along the Rhine and in close proximity to the site of Andernach-Martinsberg. Gönnersdorf was excavated by Bosinski in 1968-76, and finds from the Magdalenian horizon are known to include abundant faunal remains as well as artefacts. The faunal collection is housed at the RGZSM, Neuwied. Prior radiocarbon dating of the fauna yielded dates (Appendix 1) within the early Late Glacial (or Dryas I/Bølling Interstadial) (c. 12,900-12,400 BP).

A large quantity (a minimum of 13 individuals: Poplin, 1976) of horse remains are present from the Magdalenian levels at Gönnersdorf and the author has studied a proportion of these specimens (mainly postcranials) in detail at the RGZSM, Neuwied. One reliable radiocarbon date on horse is available and it lies within the Late Glacial range mentioned above (Appendix 1). In addition to horse, the mammalian assemblage from the Magdalenian levels includes wolf, arctic fox, red fox, mammoth, woolly rhinoceros, bison (*Bison* sp.), saiga antelope, chamois, red deer, reindeer, elk and arctic hare.

Kartstein Abri, Rhineland-Palatinate, Germany, References: Löhr (1978); Street *et al.* (1994); Bosinski *et al.* (1995); Baales and Vollbrecht (1995); M. Street (pers. comm.)

An 'abri' site, part of the so-called Kartstein ("a travertine massif containing caves"), which was excavated by H. Löhr in 1977. Finds from the Ahrensburgian (Dryas III or Younger Dryas) horizon include faunal remains as well as Ahrensburgian artefacts. A small collection of faunal remains is held at the RGZSM, Neuwied. Only one reliable radiocarbon date (Appendix 1) on the non-horse fauna is available for this site and it lies within the later Late Glacial (Dryas III) (c. 10,100 BP).

Horse remains are present from the Ahrensburgian horizon at Karstein; however, the author has only had the opportunity to study one specimen (a Phal I) in detail at the RGZSM, Neuwied. In addition to horse, the Ahrensburgian mammalian faunal assemblage includes reindeer, ?bovid (*Bos* sp), ?ibex, wolf, ?dog, red fox, arctic fox, stoat, weasel, arctic hare, steppe pika, narrow-skulled vole, northern vole, water vole, bank vole, short-tailed vole, common vole, Norway lemming, collared lemming,

European suslik, common hamster, northern birch mouse, yellow-necked mouse, ?wood mouse, and ?desman (*Galemys* sp).

Kettig, Rhineland-Palatinate, Germany, References· Street *et al.* (1994); Bosinski *et al.* (1995); Baales (1994, 1995a); Street and Baales (1997); M. Street (pers. comm)

An open occupation site in the Central Rhineland Neuwied Basin which was investigated by Baales in 1992-93. Excavations revealed a Late Glacial horizon which specifically dates to the Allerød Interstadial. Finds from this horizon include faunal remains as well as Federmessergruppen artefacts. A collection of the faunal remains is held at the RGZSM, Neuwied. Previous radiocarbon dating of faunal remains yielded a date (Appendix 1) which lies within the Late Glacial (Allerød) (c. 11,300 BP).

Horse remains are present from Kettig and the author has studied a small proportion of this collection (a pelvis) in detail at the RGZSM, Neuwied. In addition to horse, the Federmessergruppen mammalian assemblage includes red deer, roe deer, large bovid (*?Bos primigenius*), beaver, wolf, brown bear, red fox, marten (*Martes* sp.), weasel, yellow-necked mouse, common hamster, mole, bank vole, water vole, voles (*Microtus* spp.), shrews (*Sorex* spp.), Eurasian water shrew, and possibly chamois.

Miesenheim II, Rhineland-Palatinate, Germany, References: Turner (1990, 1991); Street *et al.* (1994); Bosinski *et al.* (1995); Street (1986, 1995c); Street and Baales (1997); M. Street (pers. comm.)

An open site located in the Central Rhineland Neuwied Basin (Nette Valley) first investigated in 1982-84 and formally excavated in 1985-87 (Street, 1986; Turner, 1990). Excavations revealed a Late Glacial horizon dating to the Allerød which had been sealed by a Laacher See pumice/Britz layer. Finds from this Allerød horizon include faunal (some humanly modified) and environmental (e.g. plant, pollen) remains as well as Federmesser-type artefacts. A faunal collection is held at the RGZSM, Neuwied. Prior radiocarbon dating for both environmental (organic) and faunal remains yielded dates which range within the Late Glacial Allerød (c 11,500-10,800 BP) (Appendix 1)

Horse remains are present from the Miesenheim II fossiliferous layer and the author has studied the only available specimen (an MTIII with cutmarks: see fig 4 6) at the RGZSM, Neuwied. According to Street (1995c), this bone together with those of

Fig 4.6. Horse specimens (two complete MTIIIs) from Bedburg-Königshoven, Germany (top) and Miesenheim II, Germany (bottom) (held at the RGZSM, Neuwied, Germany).

a large bovid (see below) were "found directly at the boundary of the Allerød surface with the pumice". In addition to horse, the faunal assemblage from the Allerød horizon includes red deer, roe deer, large bovid (*?Bos primigenius*), hamster (*Cricetus* sp.), mole, and water vole.

Niederbieber, Rhineland-Palatinate, Germany, References: Turner (1990, 1991); Street *et al.* (1994); Bosinski *et al.* (1995); Baales (1995b); Street and Baales (1997); M. Street (pers. comm.)

An open settlement site in the Central Rhineland Neuwied Basin (Wied Valley) first investigated in 1980. Formal excavations of the site began in 1981 and continued throughout the 1980's to the present day (Turner, 1990, 1991; Baales, 1995b). Finds recovered from a soil horizon which dates to the Allerød Interstadial of the Late Glacial include faunal remains as well as Federmessergruppen (Azilian) artefacts. A faunal collection is held at the RGZSM, Neuwied. Previous radiocarbon dating of faunal remains has yielded one reliable date which lies within the Late Glacial Allerød (c. 11,100 BP: Appendix 1).

At Niederbieber, horse remains (deciduous teeth and one astragalus) are present within the Federmesser levels. One radiocarbon date (c. 11,100 BP: Appendix 1) is available for the horse at Niederbieber and it compares well with the Late Glacial date given above. In addition to horse, the Federmesser mammalian faunal assemblage includes red deer, elk, beaver, large bovid (*Bos* sp./*Bison* sp.), ibex, chamois, badger, red fox, and wild boar ("context uncertain": Street and Baales, 1997).

Bedburg-Königshoven, North Rhine-Westphalia, Germany, References: Street *et al.* (1994), Bosinski *et al.* (1995); Street (1995b); M. Street (pers. comm.)

An open settlement site in the Lower Rhineland discovered during quarrying operations in 1987 (Street, 1989, 1995b). Further investigations revealed an early Holocene (Pre-Boreal) archaeological horizon overlying Late Pleistocene sands and gravels. Finds from this younger level include mammalian faunal remains (many humanly modified) as well as Early Mesolithic artefacts. The faunal remains are held at the RGZSM, Neuwied. Radiocarbon dating on both environmental (e.g. peat and wood) and faunal samples was undertaken previously and yielded several dates (Appendix 1) which range within the later Late Glacial (Dryas III or Younger Dryas) to early Post Glacial (Pre-Boreal/Early Boreal/Later Boreal) (c. 10,300-8,000 BP).

Horse remains are present from Bedburg-Königshoven and the author has studied a proportion (all postcranials) of the assemblage at the RGZSM, Neuwied. The majority of horse specimens probably date to the Pre-Boreal; however, at least one specimen (an MTIII: see fig. 4.6) may be younger (i.e. Boreal in age) (M. Street, pers. comm.). Unfortunately, no radiocarbon dates are available for horse from this site to corroborate these suggestions. In addition to horse, the mammalian faunal remains include aurochs, red deer, roe deer, pig, dog, badger, and beaver.

FRANCE:

Solutré, Saône-et-Loire, France, References. Argant (1985); Olsen (1989); Turner (1996); Guadelli (1986, 1987, 1991); E Turner (pers. comm.); J. Combier (pers. comm); J.-L. Guadelli (pers. comm)

An open site (a "hunting and kill locale": Turner, 1996) of immense importance located in east-central France which was first discovered by A. Arcelin in 1866 and excavated many times thereafter However, it was not until between the 1960's and the 1980's that the first formal, detailed excavations at Solutré were carried out by J. Combier (Olsen, 1989, Turner, 1996). A stratigraphic sequence at the site consists of Late Pleistocene (Weichselian) deposits (base to top: Mousterian, Aurignacian, Gravettian (or Upper Perigordian), Solutrean, Magdalenian) which have yielded abundant faunal remains (many humanly modified) as well as artefacts. The bulk of the faunal collection is held at MDPS, Solutré; however, some faunal remains are held in Lyon In the current project, the author has chosen to pay particular attention to the

faunal remains from the Aurignacian (Areas M12 and L13), Gravettian/Upper Perigordian (the loess, "magma de cheval": Areas M12, L13, J10 and I11) and, more specifically, to the Magdalenian (Areas J10, I10, P16 and I11) levels. Previous radiocarbon dating of the fauna (probably consisting entirely of horse remains: see below) from various areas has yielded dates (Appendix 1) ranging from the Middle to the Late Weichselian (c. >30,400-12,600 BP).

According to Olsen (1989), it is probable that between 32,000 and 100,000 individuals of horse are represented by remains which had become incorporated in deposits at Solutré during the 20,000 years it had been used as a site. Horse remains are abundant in the Aurignacian, Gravettian/Upper Perigordian and Magdalenian levels and the author has studied a proportion of this collection (mainly Magdalenian material [postcranials and teeth] from Areas P16 and I11) in detail at the MDPS, Solutré. Many of the horse remains investigated by the author retain the cutmarks associated with butchery (E. Turner, pers. comm.). The remains from each archaeological assemblage exhibited distinct preservation types (E. Turner, pers. comm.): Aurignacian (reddish-brown colour), Gravettian/Upper Perigordian "magma" (yellow/white with chalky concretions/matrix) and Magdalenian (grey/yellow/brown with root-etching); and these types were used as an additional guide by the author to aid in the segregation of material to be studied. For the purposes of the current study and in collaboration with E. Turner's current work on the faunal collection at Solutré, two new radiocarbon dates (table 4.5) for horse from Magdalenian levels (Areas P16 and I11) have been obtained. Both dates, although they lie within the Late Weichselian range mentioned above, are pre-Late Glacial or Middle Magdalenian (c. 15,100 BP and c. 14,600 BP) and not Late Magdalenian as is the previous date (Ly-393: Appendix 1) for a horse specimen from Area P16. Also, it must be mentioned that the holotype specimens for the "*gallicus*" and "*arcelini*" subspecies (see table 2 2, chapter 2) both originate from Solutré deposits (i e. Upper Perigordian [Area J10] and Late Magdalenian [Area P16], respectively). As mentioned previously in chapter 2, according to Guadelli (1986, 1987, 1991), the horses from both the Aurignacian and Perigordian levels are designated "*gallicus*", while the Magdalenian horses are designated "*arcelini*" based on morphological criteria See chapter 5 for a further test of these criteria as well as a morphological comparison of the Solutré horses with those of Britain/Ireland. In addition to abundant horse, the Magdalenian mammalian faunal assemblage includes reindeer, bovid (*Bos* sp./*Bison* sp), mammoth, fox, hare, wolf, rodents and possibly roe deer.

Bruniquel [Courbet] (or Trou des Forges), Commune Penne-Tarn, Tarn-et-Garonne, France, References: Owen (1869); Cartaillac (1903); Sieveking (1987); Gordon (1988); Cook and Welté (1992)

A French Upper Palaeolithic cave site first explored by Vicomte de Lastic Saint-Jal in 1863 and then by de Lastic, M. des Serres and R. Owen in 1864. The cavern is located within the face of a massif or cliff (now known as Courbet) which lies near the village of Bruniquel. According to Owen (1869), at the time of discovery, there was "no evidence that the 'caverne de Bruniquel' has been known or described by any other name or that the name has been applied to any other cave". Sieveking (1987) notes, however, that this cave subsequently has acquired at least two other names (e.g. Courbet and Trou des Forges) and that Courbet is the name currently adopted by French prehistorians. It is thought that the majority of remains are derived from de Lastic's black layer or "couche noire" which is thought to date to Magdalenian V or VI; however, the provenance of remains within this layer is not clear (Sieveking, 1987). Furthermore, Owen (1869) notes that both human and animal remains were found within not only a black layer ('limon noir'), but also a red layer ('limon rouge') and a breccia deposit. Owen (1869) took such an interest in the cave itself as well as the faunal and artefactual (e.g. Palaeolithic art objects) remains which had been recovered that he purchased de Lastic's first collection for the British Museum in 1864. The faunal collection is now housed at the NHM while most of the artefacts are housed at BMFH. Subsequent radiocarbon dating of faunal remains (artefactual) has yielded two dates (Appendix 1) which lie within the Late Glacial (c. 11,800 BP and c. 11,100 BP).

Horse remains are present in large quantities from Courbet and the author has examined all available specimens (teeth, cranials and postcranials) from Owen's 'de Lastic Collection' in detail at the NHM. According to Owen (1869), the horse remains acquired by him in 1864 consisted of at least 30 individuals from the limon noir, limon rouge and the breccia; however, the remains (including those remains left behind or thrown out) probably represented a total of about 100 individuals Many of the remains studied by the author retain the cutmarks associated with butchery, especially the teeth and maxillary/mandibular elements. Also, it is evident that the remains have been treated with an unknown preservative Radiocarbon dating of horses from this collection by the present author has yielded one reliable date (table 4 5) which lies

within the early Late Glacial (c. 13,200 BP). Owen (1869) designates these horses taxonomically as "*Equus spelaeus*" (see chapter 2); and notes that based on tooth (M3) size, two types or varieties are present amongst these remains: a smaller "var A" and a larger "var. B". A further discussion of the morphology and taxonomy of these horses can be seen elsewhere in the present work (chapters 5 and 6) Additional information regarding the horses of Courbet is provided by the many art objects (i.e. engravings or drawings) which portray horses One particular engraving of a horse's head on a horse bone (an MTIV or metatarsal splint bone: no. 38475), discovered by the present author, is discussed in more detail in chapter 2. In addition to horse, the mammalian faunas depicted in the art include ibex, reindeer, bison, aurochs, musk ox and human (Sieveking, 1987; Gordon, 1988); while the de Lastic collection of mammalian faunal remains from Courbet include a cervid ("*Cervus palmatus*"), ?chamois? ("*Rupicapra christolii*"), ibex, aurochs, red fox, wolf, arctic hare and reindeer.

BELGIUM:

Trou de Chaleux, Province de Namur, Belgium, References: Dupont (1865); Otte and Teheux (1986); Cordy (1991); Charles (1993, 1994); Otte (1994); R. Charles (pers. comm.); M. Germonpré (pers. comm.)

A cave site excavated by E. Dupont in 1865 and most recently by M. Otte in 1985-88 (Otte and Teheux, 1986). Finds include faunal remains as well as Late Magdalenian artefacts. The focus of the current study is on the abundant faunal material (including many humanly modified specimens) recovered by Dupont in the 19th century from the "1er niveau ossifère" or hearth layer. This faunal collection is held at the IRScNB, Brussels. Radiocarbon dates (both conventional and accelerator) on the fauna from both excavations are available, and the majority lie within the Late Glacial (c 13,000-12,400 BP) (Appendix 1); however, one date (Appendix 1) lies within the Holocene (c. 3,100 BP).

A large collection of horse remains are present from both excavations of Chaleux and the author has studied a proportion of the specimens (teeth and postcranials from the Dupont collection (1907)) at the IRScNB, Brussels Many of the horse specimens retain the cutmarks associated with butchery. Previous radiocarbon dating of horse remains produced dates (Appendix 1) which lie within the Late Glacial range mentioned above. In addition to horse, the mammalian faunal assemblage includes red deer, reindeer, saiga antelope, bison, aurochs, musk ox, chamois, ibex, wild boar, wolf,

hyaena, brown bear, red fox, arctic fox, badger, a felid (*Felis* sp. and/or *Lynx lynx*), hare (*Lepus* sp.), sheep and goat. Interestingly, the Otte excavations (Otte, 1994) yielded additional equid remains identified as the stenonine *Equus hydruntinus* (see chapter 2). Although the author did not examine these specimens personally, the identifications are considered suspect based on the type and number of '*hydruntinus*' specimens actually identified (i.e. only two: a calcaneum fragment and a proximal end of an MCII or splint bone [a sporadic find, in most cases]) as well as their dubious condition (i.e. fragmentary specimens).

4.5 Discussion of the dating evidence with special reference to newly radiocarbon-dated horse specimens

4.5.1 Introduction

Ideally, data for the definitive chronological study of latest Pleistocene to Holocene horses would incorporate a long, complete stratigraphical section through this time period, with mammalian remains (including horse) at every horizon. This ideal does not exist in north-west Europe; and in reality, only a large number of separate sites, covering different intervals of time are available. Previous dating evidence indicates the presence (i.e. positive evidence) and/or absence (i.e. negative evidence) of horses in particular areas during particular periods. Ultimately, these dates can unveil a pattern of discontinuity or continuity for European horses which may be evidence of underlying factors. For example, gaps in the record, as evidence of discontinuity, may be due to disappearance of horses from certain areas (e.g. Britain) as a result of environmental change. The only way to test the reliability of these gaps is to emphasise the sampling and dating of specific sites and their horse material in relation to environmental factors such as climate and vegetation. In Britain/Ireland and on the Continent, inefficient sampling and dating techniques need to be identified in order to rectify many of the existing problems. Thus, a main aim of the current project is to highlight the horse dating evidence (both positive and negative); firstly, in Britain/ Ireland; secondly, in continental Europe, and thirdly, the two areas in comparison. Although the current author has chosen to limit the geographical scope of this project to the British Isles and continental Europe, it is important to mention the implications of such a choice. For example, it is possible that the imposition of these limitations causes important factors relating to horse chronology during the key periods in

important areas (e.g. Asia) to be missed. On the other hand, it may be feasible to analyse some of these eastern populations in another manner (e g. morphological comparisons in relation to chronology: see chapter 5).

New and previously obtained dates have already been mentioned in the gazetteers above; however, in this section, many will be re-emphasised and assessed in relation to site stratigraphy as well as the provenance of individual specimens, other dates and fauna (some associated), and known Late Pleistocene/Holocene palaeoenvironments.

4.5.2 Review of the dating evidence for horse: Britain and Ireland

Previous evidence

The previous data (some of which were recently obtained by other researchers) have provided much information which has been instrumental in compiling a chronological distributional history of this species. These dates represent a mixture of the types described above in section 4.2.2 (i.e. direct dates, bulked dates and associated/general site dates). The most significant, however, are the 71 reliable (i.e. excluding mixed species bulked determinations) direct radiocarbon dates for British/Irish horses from 40 different Mid-Devensian to Holocene sites. The dated material consists exclusively of bone and tooth. Below, is a review of this and other existing dating evidence relating to horse material from the three key periods (i.e. Middle to Late Devensian, Late Glacial/early Post Glacial, and middle Holocene and later) highlighted in the gazetteer of British and Irish sites (sections 4.3.2 and 4.3.3).

- Middle to Late Devensian (excluding specifically Late Glacial dates).

Horse material from six separate sites (five British/one Irish) have produced six dates which lie within the Mid-Devensian (c. 44,900-27,600 BP). However, only one of these existing dates (Shandon Cave, Ireland) is younger than the 30,000 BP limit for finite radiocarbon dates It is not clear whether dates close to or over this threshold signify the real age of the specimens and they may be considered infinite based on this uncertainty (Pilcher, 1991b). Because horse appears to be prevalent during this period and many sites contain good samples of horse remains, it is surprising that so few horse dates are available for this period of the Late Pleistocene. However, see

Overview and Conclusions (this section) for a discussion of Mid-Late Devensian dated sites without horse remains (section 4.3.4).

The majority of horse dates from the six sites seem to correspond to dates on other Mid-Late Devensian fauna from these sites; however, one site (Torbryan 6) stands out as having yielded a Middle Devensian horse date (c. 32,000 BP) while the other fauna (albeit from a younger horizon) appear to be of mixed Late Glacial age (c. 12,100 BP and c. 11,100 BP). It is evident that two horse faunas are present at some sites (e.g. Kent's Cavern), one dated to the Mid-Late Devensian and the other dated to the Late Glacial (Appendix 1). In some cases, however, it may be that no Late Glacial horses have yet been identified from the site (e.g. Pin Hole Cave). In addition to the horse material providing reliable dates, morphological differences (e.g. size) between Mid-Late Devensian and Late Glacial horses is useful in separating them chronologically. See chapter 5 for a thorough discussion of the morphological evidence in relation to chronology.

It is clear that the available horse radiocarbon dates for this period are representative of material that serves an associative purpose (i.e. the horse specimens were chosen only to confirm and compare bio-stratigraphical provenance). Thus, the dated horse along with the other dated fauna allow for stratigraphic correlation with nearby sites. For example, the Torbryan 6 horse date mentioned above is thought to correlate with the stratigraphy at the nearby Tornewton Cave (Hedges *et al.*, 1996: AM22) for which there is horse as well as Mid-Late Devensian dated non-horse material. However, it must be pointed out again that because no dated horse remains are available for Tornewton, the present author does not consider the horse there to certainly date to the Mid-Late Devensian.

Four key points can be made with reference to the selected sites with supposed Mid-Late Devensian horses listed in the gazetteers of the preceding sections (4.3.2, 4.3.3). 1) Many of the sites (e g Welsh sites. Priory Farm Cave, Gop Cave, Potter's Cave) have no previous faunal/environmental dates (i e associated or general site non-horse dates) at all; 2) Some of the sites (e g. Church Hole Cave, Conningbrook Pit) have only previous associated or general site dates which either lie solely within the Mid-Late Devensian or range within the Devensian to Holocene; 3) Six (see above) of the sites (e g Hyaena Den, Pontnewydd Cave) have previous direct horse dates in addition to associated or general site dates which either lie solely within the Mid-Late Devensian or range within the Devensian to Holocene, and 4) A few of the sites (e g.

Merlin's Cave, Elderbush Cave) have only previous associated or general site dates which lie solely within the Late Glacial/Post Glacial. For a further discussion of these points see *Overview and Conclusions* (this section).

- Late Glacial/early Post Glacial:

Five key points can be made in reference to the selected sites with supposed Late Glacial/early Holocene horses listed in the gazetteers of the preceding sections (4.3.2, 4.3.3): 1) The majority of sites from this period (e g. Cathole Cave, Moughton Fell Cave) had no existing radiocarbon evidence at all prior to the current project; 2) Several sites (e.g. King Arthur's Cave, Dead Man's Cave) have previously provided only associated or general site dates, which either exclusively date to this period or range within the Late Pleistocene to Holocene; 3) Several sites (e.g. Chelm's Combe, Seamer Carr) have provided previous associated or general site dates together with horse dates which either exclusively date to this period or range within the Late Pleistocene to Holocene; 4) A few sites (e.g. Little Hoyle Cave, Thor's Fissure Cave) have provided only associated or general site dates which date exclusively to the earlier or later periods (i.e. Mid-Late Devensian or Post Glacial only); and 5) One site (i.e. Uxbridge) has provided previous horse dates which are exclusively Late Glacial.

Looking at the tables in Appendix 1, it is clear that the majority of available previous horse dates pertain to this period (c. 13,000-9,000 BP). Material from several sites (14 in total: all British), has previously yielded 36 reliable dates. It is evident that only a few Late Glacial sites have more than one date on horse (e g Gough's Cave [16 dates], Mother Grundy's Parlour [4 dates]); and not surprisingly, these two examples are sites with good samples of horse material. In addition, no Irish sites have yielded any Late Glacial/early Post Glacial dated horse, and only one Scottish and Welsh site each are represented (i e. Green Craig and Kendrick's Cave, respectively). This bias towards English sites/dates may or may not be meaningful (see below); however, as alluded to above, the lack of Late Glacial horse in Ireland appears significant. Woodman *et al. 's* (1997) recent Irish Quaternary dating program which set out to date some important faunal material from key Irish sites (some extremely well-known) has provided the evidence (although negative) to suggest that horses were absent in Ireland during the Late Glacial/early Post Glacial period. Considering that Middle Devensian horses (i.e. Shandon Cave evidence see above) were clearly present in that region, this

issue raises some interesting questions regarding distributional transitions in the Late Pleistocene of both Britain and Ireland (see section 4.6).

Importantly, it must be noted that the majority of reliable horse dates for this period were obtained directly from individual specimens rather than from bulked samples. Only one reliable date (i.e. Sun Hole: Birm-821) was obtained from a bulked horse-only sample. The other dates obtained previously for Sun Hole horse are considered unreliable by the author due to one (Birm-820) having been obtained from a mixed species bulked sample and one (OxA-4986) from a supposedly contaminated specimen. These Sun Hole determinations (see Appendix 1) are three clearly different dates, although the two bulked samples are the closest in both period (i.e. Younger Dryas) and age obtained (c. 10,500-10,000 BP). This is a good example of the kinds of discrepancies which are apparent among the previous horse dates. Thus, the problems of preservational status of specimens and contamination are two of the issues which dominated the selection of specimens for radiocarbon dating in this project (see below).

In figure 4.7, the previous horse dates (i.e. excluding the dating done for the current project) are shown and the emergent pattern appears clear. There is an apparent chronological continuity in two separate periods of the Late Glacial, one during the early part of the Windermere Interstadial (i.e. within the Bølling: c. 12,900-12,000 BP) and one during the latter part (i.e. within the Younger Dryas/Pre-Boreal: c. 10,500-9,600 BP). However, because there is apparent chronological continuity, this does not mean that geographical continuity across Britain exists in tandem. In fact, a fragmented geographical distribution may exist during these periods. For example, southern sites (e g those in Somerset and Devon) with horse may be overrepresented on the datelist, thus biasing horse distribution during the Bølling towards the south of Britain. For a more in-depth discussion regarding the geographical aspect of horse chronology see section 4.6.

Also, figure 4.7 highlights apparent gaps in the radiocarbon record of British horses. A significant gap can be seen between the two periods mentioned above (c. 12,000-10,500 BP). This gap happens to occur during the "Older Dryas"/Allerød Interstadial, the Allerød considered as having been ecologically unsuitable for horses due to the increased presence of forested conditions in Britain A further discussion of this important issue (i e. environmental factors) in relation to geography and chronology can be seen in section 4 7. Another gap is evident at c. 9,600 to c. 9,100

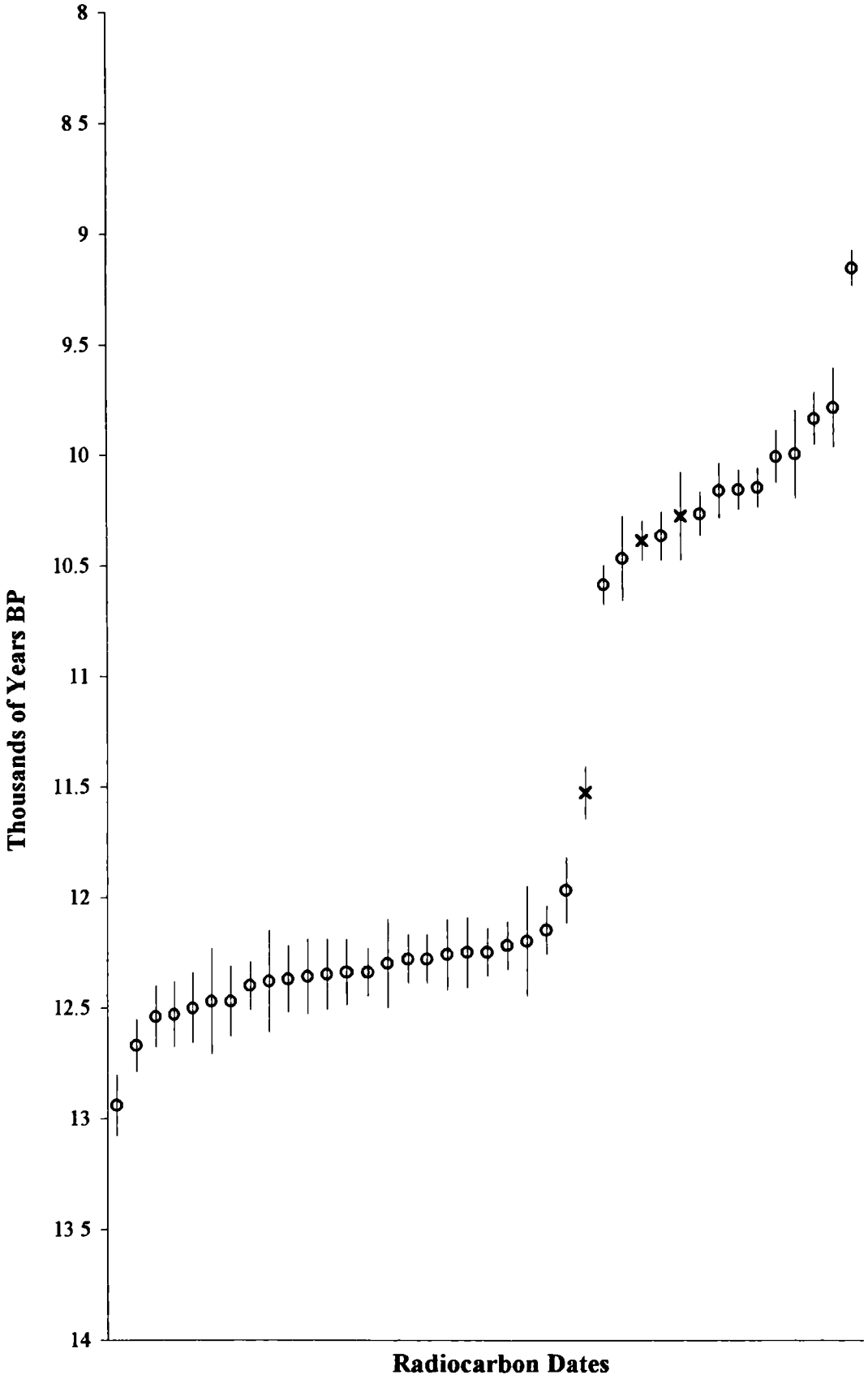

Fig 4 7. Late Glacial/early Post Glacial radiocarbon record for British horses showing previous published dates only (± error bars shown with: open circle= reliable date, cross= unreliable date)

BP, for which there is only one previous Pre-Boreal date (Flixton II: c. 9,200 BP) at the later end of the spectrum. This date is the only positive evidence for the presence of horse during the later Pre-Boreal. The overall lack of previous horse dates for both the terminal (or latest) Late Glacial and the early Post Glacial (Pre-Boreal/Boreal) periods suggests that it is difficult to convincingly assess chronological/distributional continuity during this c. 500 year gap as well as the apparent gap post-9,100 BP, both shown in figure 4.7.

Another important aspect of dating within this period is the amount of correlation between horse dates and the associated or general site dates for particular sites (see tables in Appendix 1). In other words, do the horse dates correlate with non-horse dates or do they provide original chronological evidence for the site? Three scenarios are possible for the previous horse dates: 1) They date within one period of the Late Glacial/early Post Glacial and correlate well with the associated or general site dates; 2) They date to two or more periods within the Late Pleistocene/Holocene (including the Late Glacial/early Post Glacial) and correlate well with the previous associated or general site dates; and 3) They date within the Late Glacial/early Post Glacial and do not correlate with the associated or general site dates (i.e. they represent a period not covered by the associated/site dates). The majority of sites (e.g. Gough's Cave, Kent's Cavern) with existing horse dates conform to scenarios (1) or (2); however, a few sites (e.g. Robin Hood's Cave, Mother Grundy's Parlour, Green Craig) with existing horse dates can be considered as scenario (3). It is clear that the horse dates highlighted in figures 4.8a and 4.8b for Gough's Cave and Kent's Cavern fit well with the rest of Late Glacial dates for the site. In fact, with respect to Gough's Cave, there are as many previous horse dates as there are Bølling (c. 13,000-12,000 BP) non-horse dates for the site. On the other hand, figures 4 8c and 4.8d for Mother Grundy's Parlour and Robin Hood's Cave show that the previous horse date for these sites do not correlate completely with the non-horse dates. The dates for Mother Grundy's seem to extend the presence of fauna at the site to a slightly earlier interval (c. 12,500-12,300 BP) within the Bølling. More convincingly, however, the sole reliable previous horse date for Robin Hood's Cave is clearly the only one for the site which dates to the Younger Dryas, all other non-horse Late Glacial determinations dating to the Bølling Extenuating circumstances (e g human occupation of the site) may justify the difference in species presence during a particular period at a particular site. For example, at Robin Hood's Cave, it appears that all the Late Glacial non-horse dates

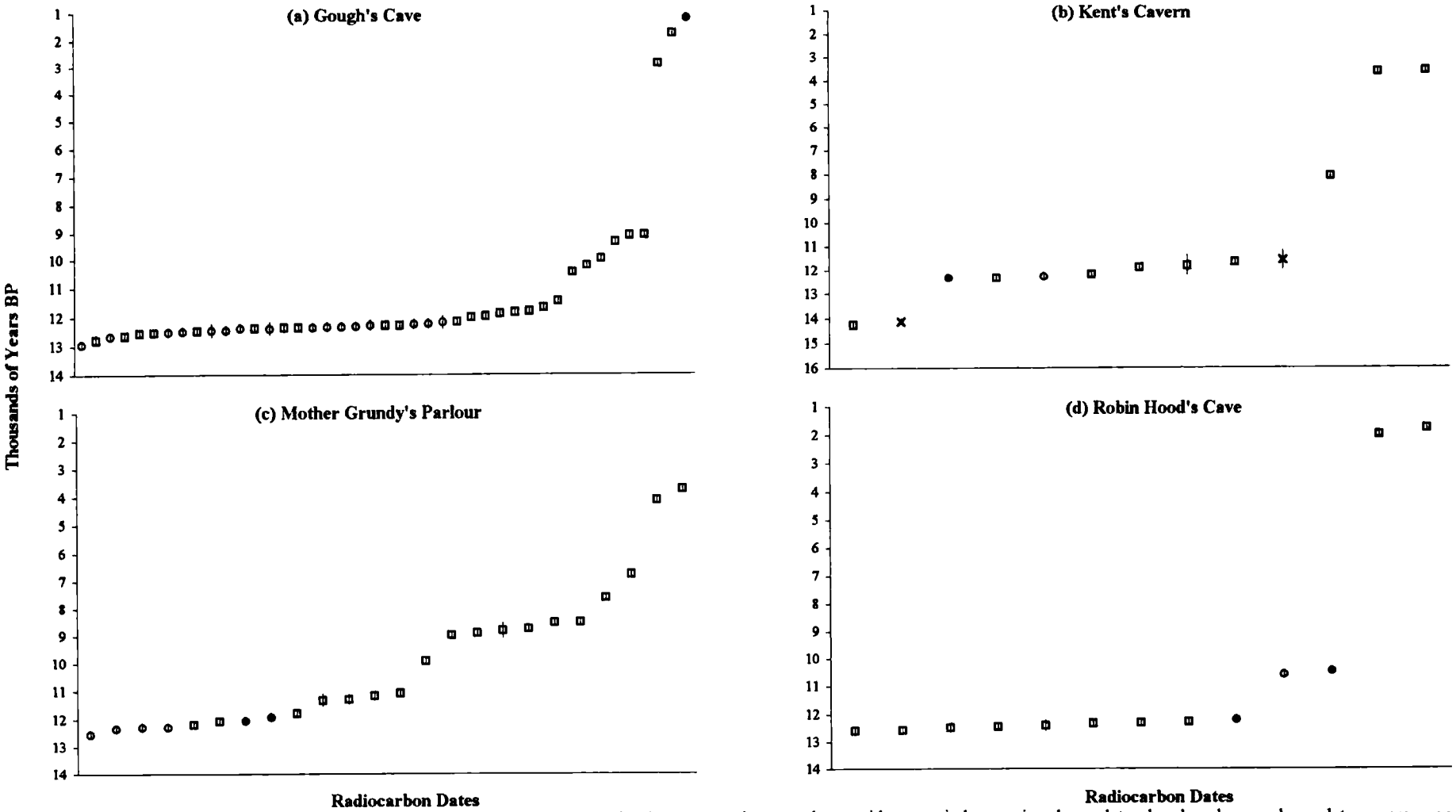

Fig 4 8(a-d) Radiocarbon record for horse and non-horse from four British Late Glacial sites. (± error bars are shown with: open circle– previous horse date; closed circle new horse date; square– non-horse date cross unreliable date)

were obtained on specimens with a human association (e g cutmarks as butchery evidence), thus it might have been assumed that the Bølling faunal assemblage accumulated as a result of human occupations rather than as a build-up by non-human means (e g. natural predators such as wolves) However, the author is sceptical about relying solely on faunal dates obtained from specimens directly associated with humans See *Overview and Conclusions* (this section) for an in-depth discussion of these issues.

- Middle to late Holocene (Late Mesolithic/Neolithic/Bronze Age and later):

A few key points can be made about the previous middle Holocene and later dating evidence from the sites listed in the gazetteers (sections 4.3.2, 4.3.3). Looking at the tables in Appendix 1, it is obvious that there is a lack of multiple dates on horse for sites dated to this period and later. Most are single dates on specimens or two dates for one individual of horse from one stratigraphic level (e.g. Etton). It is rare that two or three separate dates are available from one site (e.g. Wilsford Shaft, Tees estuary) or several attempts which date differently provenanced material. It is probable that a lack of sufficient sample sizes are compounding these dating problems at most sites; however, it seems unfortunate that only one horse date (OxA-3428. 2,790 ±70 BP) is available from sites such as Runnymede Bridge (Done, 1991) which has such a good and varied sample of horse material (i.e. at least four individuals represented).

Furthermore, it is clear that many more key sites lack previous horse dates (e.g. Fussell's Lodge) than those with them (e.g. Runnymede Bridge, Etton); and importantly, there are almost as many sites (e.g. Overton Hill) with no radiocarbon evidence at all as those with only associated or general site dates (e.g. Durrington Walls). Interestingly, Grigson (1966, 1978) believes that the evidence of occurrence of horse at so many mainly Neolithic sites virtually secures its presence within the British fauna during this period. However, it appears that despite its apparent presence at Neolithic/Bronze Age sites throughout Britain and Ireland, the dating of horse remains in order to validate its prevalence within this important period has been sadly neglected Below is a summary and discussion of the 29 dates which were available prior to this study (Appendix 1)

The 29 previous dates can be separated into two periods within the Holocene. Dates in the key period (i e. later Mesolithic to Early Iron Age. c. 9,000-2,000 BP) range from c. 3,900-1,800 BP and comprise 12 reliable dates from eight (all British)

sites (Appendix 1). It is also necessary to mention the previous dates which are available from the later Holocene period (i.e. Iron Age and later: post-c. 2,000 BP) (Appendix 1). They range from c. 1,700-60 BP and comprise 17 reliable dates from 13 sites (including two Scottish and six Irish sites). Regarding the reliable dates from the early to middle Holocene, it is significant that none lies within the crucial early Post Glacial period, which incorporates the Later Boreal (zone VI: c. 9,000-7,500 BP), Atlantic (zone VIIa: c. 7,500-5,000 BP), and Sub-Boreal (zone VIIb: starting at c. 5,000 BP) climatic intervals as well as the later Mesolithic and Neolithic cultures (Cunliffe, 1993). Figure 4.9 highlights this apparent 5,000 year gap in the Post Glacial radiocarbon record for British horses. It is not until the Late Neolithic (i.e. at Grimes Graves c. 4,000 BP: Appendix 1) that the first reliable positive evidence for the presence of horses in the middle Holocene occurs. There was apparently, however, evidence to suggest that horses were present in Britain c. 1,000 years earlier than at Grimes Graves. The Neolithic site of Drayton Cursus yielded one radiocarbon date (HAR-6477: 4,990 ±100 BP) for a bulked sample of mixed species including horse. This date may point to horses being present in Britain during the latter part of the Atlantic climatic period. On the other hand, due to the bulked nature of the date as well the excavator's doubts about the true provenance of the horse specimen used, the date must be considered as unreliable (see fig. 4.9 and gazetteer: section 4.3 2). Drayton Cursus serves as an example of a badly dated Neolithic assemblage having only bulked dates for the faunal material which is no longer available for further study due to the destructive nature of the dating technique used. Thus, there is now no way to re-date this once potentially important horse find.

Post-4,000 BP there is only one other smaller, but possibly significant, gap in the radiocarbon record between c. 3,500-3,100 BP (fig. 4.9), during the earlier Bronze Age. However, because some British sites (e.g. Snail Down, West Row Fen) have associated or general site dates which lie within this period, it cannot be ruled out that the horse remains in these assemblages may also date within this interval Finally, the dating evidence (fig. 4 9) suggests that horses were continually present in Britain from c. 3,100 BP onward (i e the later Bronze Age and later).

Again, it is important to look at the previous horse dates in comparison with the non-horse dates from specific sites (see gazetteers sections 4.3 2, 4 3.3) to highlight the correlation or lack of it. The scenarios for previous horse dates within this period are as follows: 1) the dates are within one period and fit in with the middle Holocene

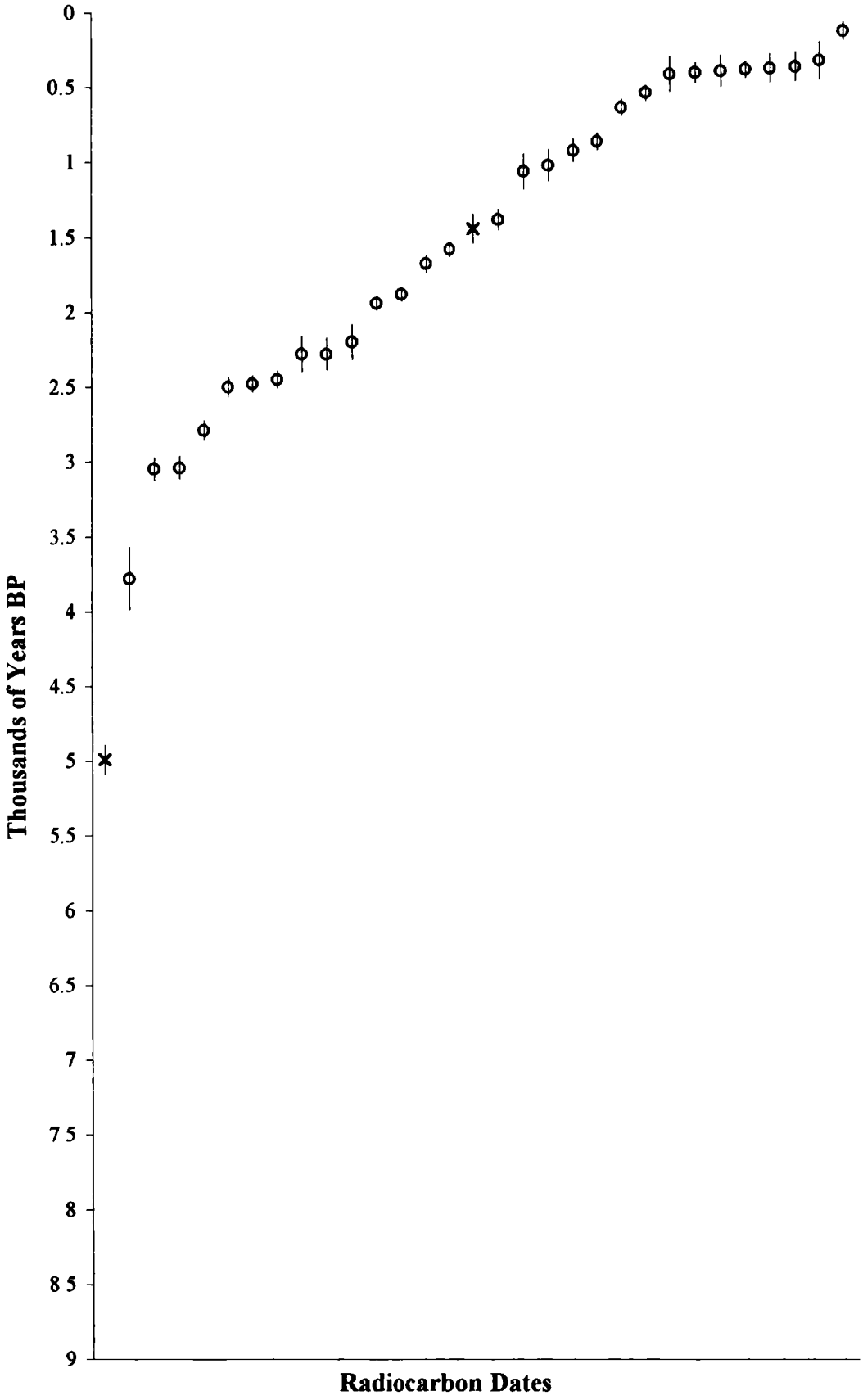

Fig. 4 9. Post Glacial radiocarbon record for British/Irish horses showing previous published dates only (± error bars shown with. open circle= reliable date; cross= unreliable date).

associated or general site dates; 2) the dates are split between two or more periods within the Holocene and fit in with the associated or general site dates, and 3) the dates do not fit in exactly with the middle Holocene associated or general site dates (i.e. represent a period not covered by the associated/site dates). It is evident within this period that a majority of sites (e g. West Overton, Lingey Fen, Quanterness) have dates which conform to scenario (3). For example, figures 4.10a and 4.10b (West Overton and Lingey Fen, respectively) show that the horse date at each of these sites falls outside the range of the non-horse dates at the younger limit, though not by much. Moreover, figure 4.10c for Quanterness shows clearly that the horse date lies well outside the non-horse previous dates range at the younger limit, thus representing a later Holocene intrusion into Neolithic deposits (Hedges *et al.*, 1995).

Despite the majority of sites with dates conforming to scenario (3), a number of sites (e.g. Etton, Wilsford Shaft) have dates which conform to scenarios (1) or (2). Figures 4.10d and 4.10e show that the Etton and Wilsford Shaft previous horse dates conform well with the non-horse associated or general site dates for their respective site. One site (Drayton Cursus) is again in a dubious position regarding its previous dates. If the bulked date which includes horse is to be accepted as reliable, it too conforms to scenario (1)/(2) because this date fits in well with the non-horse associated or general site dates (fig. 4.10f). However, since this date is regarded as unreliable (see above), the only acceptable proposal would be to highlight, instead, the site's remaining reliable horse date (a Recent date of c. 400 BP: see fig. 4.10f and Appendix 1) which conforms to scenario (3).

It may also be significant that these middle Holocene and later dated horses (twelve from eight sites: c 9,000-2,000 BP) retain some evidence of their association with humans. Often this evidence is indirect and consists of origination within an archaeological deposit, and possibly in association with artefacts and/or domesticated animals. Also, evidence from some Holocene sites seems to point to the development of a more devoted 'relationship' between humans and horses. Sites such as Grimes Graves, Etton, Runnymede Bridge and Kirkburn all provide evidence of this relationship in the deliberate, possibly "ritual", horse burials which have been discovered at each site (see gazetteer section 4 3.2). Most importantly, each of these buried horses has been radiocarbon dated (Appendix 1), and the activity appears to date within this period from the Late Neolithic at Grimes Graves (c 3,700 BP) through to the later Bronze Age at Etton (c. 3,000 BP) and Runnymede (c 2,800 BP)

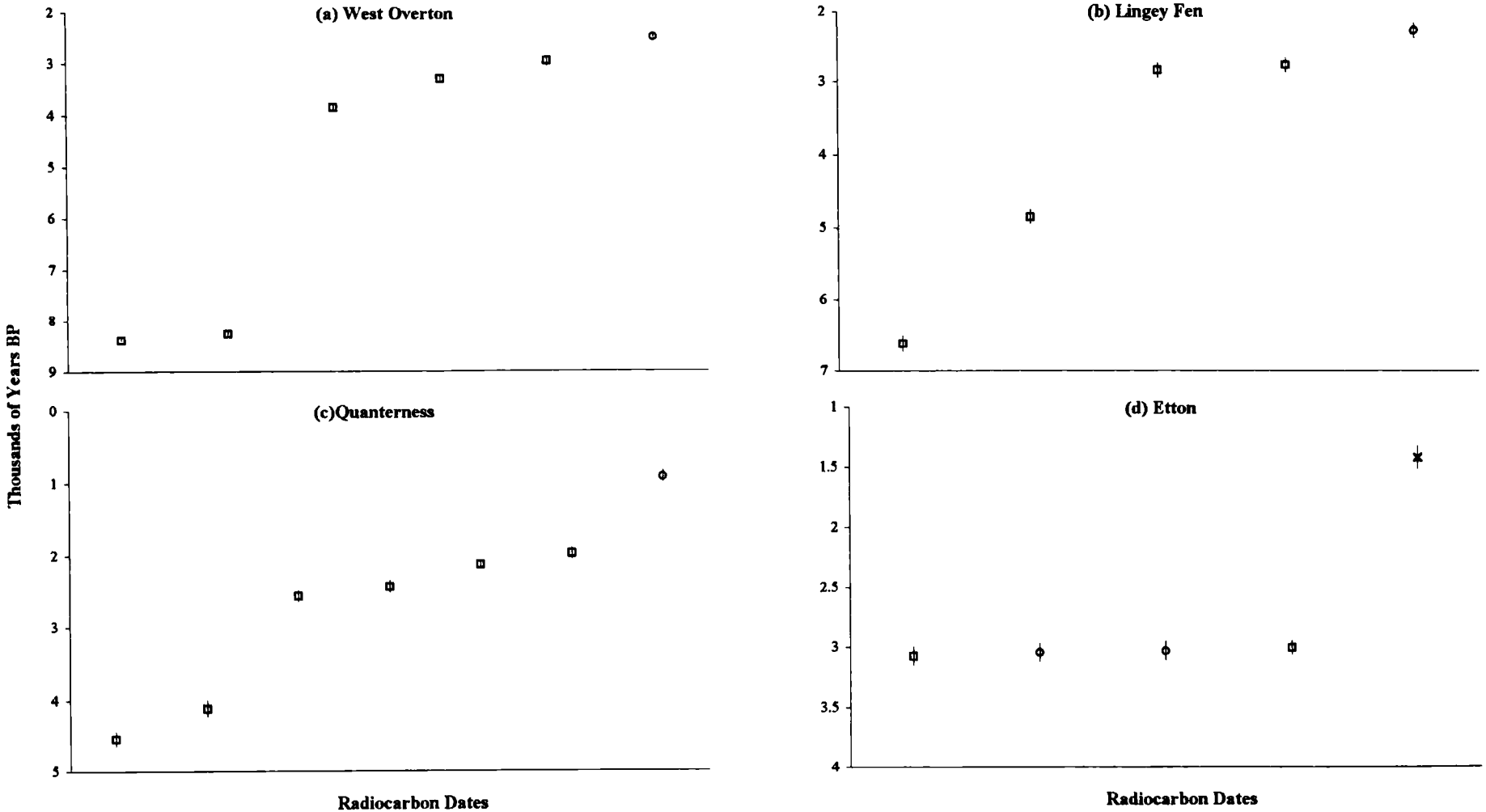

Fig 4 10(a-d). Radiocarbon record for horse and non-horse from British Post Glacial sites. (± error bars are shown with: open circle– previous horse date; closed circle= new horse date, square– non-horse date, cross unreliable date).

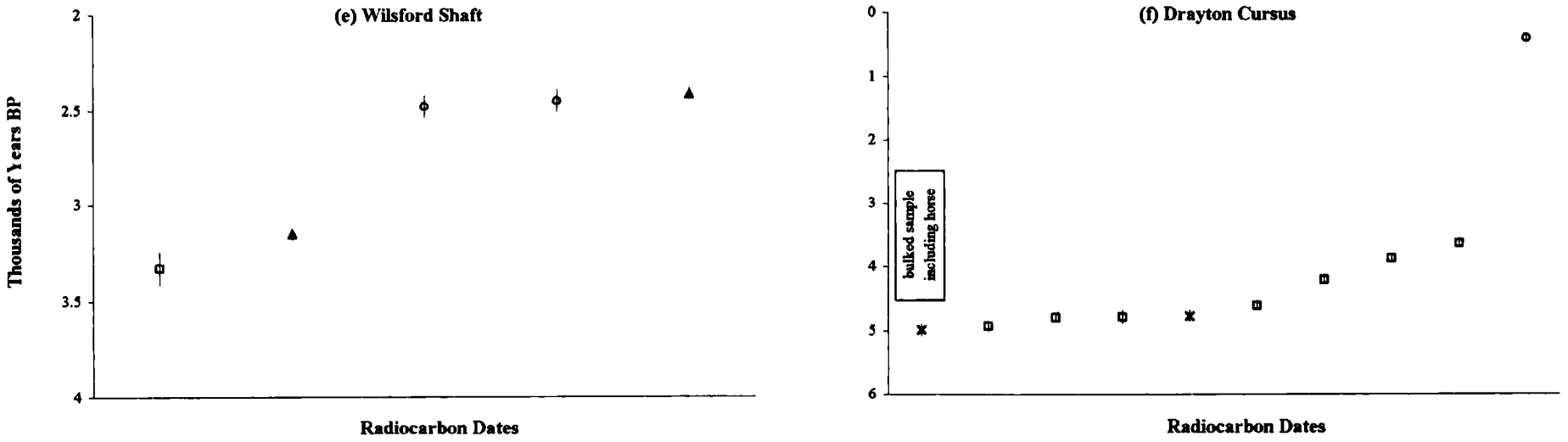

Fig 4 10(e-f) Radiocarbon record for horse and non-horse from British Post Glacial sites. (± error bars are shown with: open circle– previous horse date; square= non-horse date, cross unreliable date; triangle grouped non-horse dates).

and on to the Iron Age/early Roman at Kirkburn (c. 1,900 BP). For a further discussion of the human/horse relationship from the Late Pleistocene through to the Holocene see chapter 6.

New evidence

The main aim of the current radiocarbon dating project is to provide direct dates for horse remains from a carefully selected subset of localities, in order to expand and fill in the existing, insufficient radiocarbon record for this species (see fig. 4.11). Sites and horse remains have been identified and selected to cover as much as possible of the overall period of interest (i.e. Mid-Devensian to Holocene). The fact that there are already 71 reliable radiocarbon dates spanning this period (see above) does not mean that it was unnecessary to do any more. Newly obtained dates have aided in creating a fuller picture of horse distribution in Britain during specific periods within the Late Pleistocene to Holocene from which genuine conclusions can be drawn. For example, many of the sites were specifically chosen because they appeared, on other grounds, to date to crucial periods (e g. the later Late Glacial/early Post Glacial boundary) relevant to the current study. Also, because some of the horizons yielding horse material already have associated radiocarbon dates on other material (e.g. fauna, wood, charcoal), these have been utilised to estimate the possible age of the horses; however, in no way do they act as a substitute for, or preclude the need for, direct dates. As alluded to above, because of the possibility of specimens moving between levels, or excavational or curatorial errors, it has been imperative to directly date the horses themselves in order to get the clearest picture.

As a result of the current work, 45 reliable dates on horse material from 31 selected localities can now be added to the British/Irish Late Pleistocene/Holocene record (table 4.5 and Appendix 1) Of the 31 sites, 24 of them consist of newly dated remains which represent the first dated horses for a site (e g. Aveline's Hole, Somerset) and in some cases, a site's first dated fauna (e g. Cathole Cave, Gower) as well. In fact, one of the main reasons for dating particular horse specimens from key British sites was to provide new and original dates. These dates contribute many important new facts, and below is a review of the new dating evidence relating to horse material from the three key periods (i e Middle to Late Devensian, Late Glacial/early Post Glacial, and middle Holocene and later) highlighted in the gazetteers of British and Irish sites (sections 4.3.2, 4.3.3).

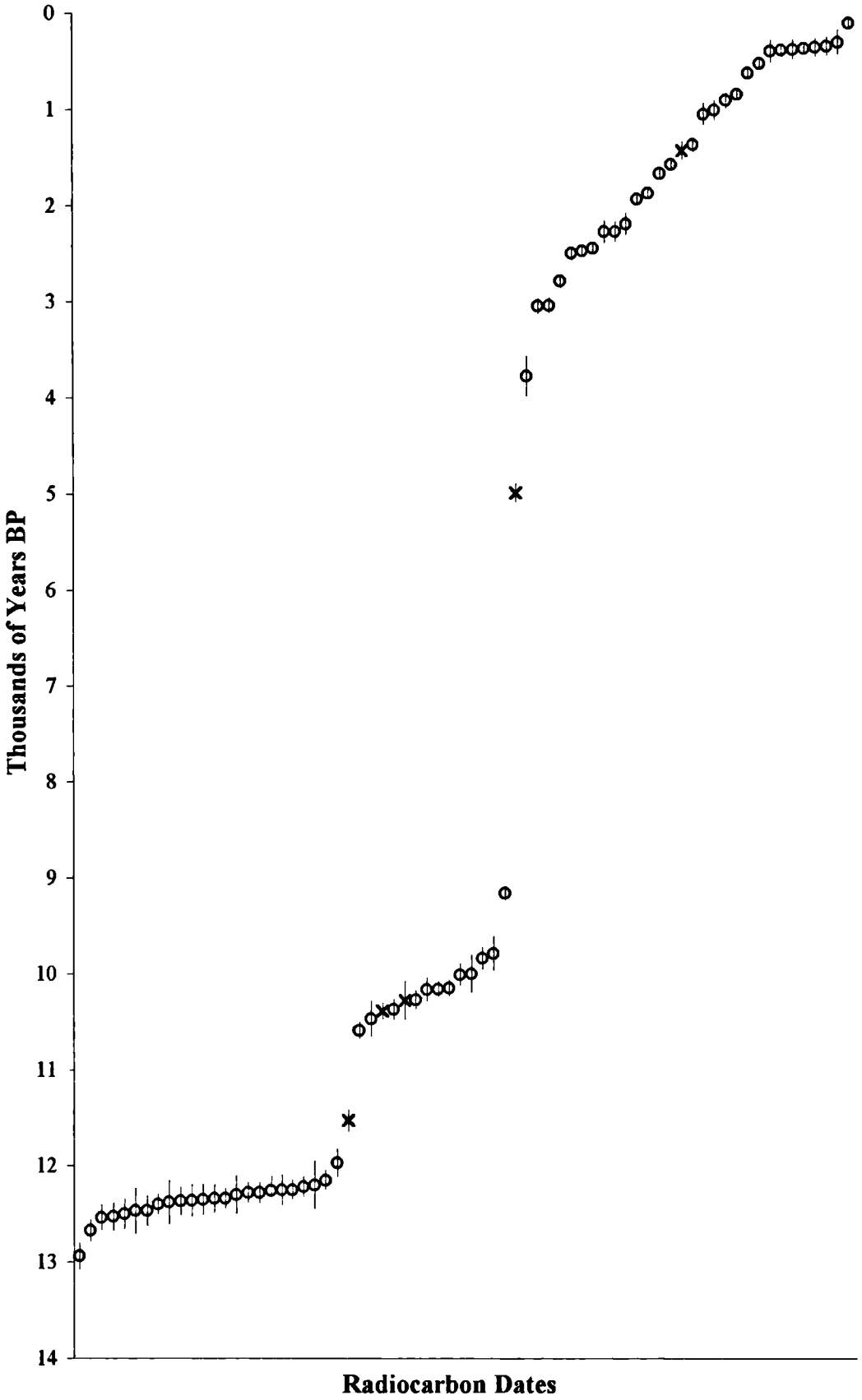

Fig 4 11. Late Glacial/Post Glacial radiocarbon record for British/Irish horses showing previous published dates only (± error bars shown with open circle= reliable date; cross= unreliable date).

- Middle to Late Devensian (i.e. excluding specifically Late Glacial dates):

Originally, the intention of the current project was not to specifically date horse material from Mid-Late Devensian sites, and certainly, the two sites which have provided newly dated horse material (i.e. Elderbush Cave, Staffordshire and Clevedon Cave, Somerset) can be considered as mixed Late Pleistocene age sites. Because the faunal assemblage was of mixed Devensian type, the Elderbush Cave specimen was radiocarbon dated in order to check if horse was associated with the previously dated Late Glacial fauna (e.g. reindeer). The Middle Devensian date (c. 33,000 BP) obtained suggests that the stratigraphy at Elderbush Cave is more secure than was first thought, and that Bramwell's (1964) assertion that Late Glacial horse was absent at the site may indeed be correct. See chapter 5 for further evidence provided by the morphology of this and other Mid-Late Devensian specimens. Because Clevedon Cave had no previous dating evidence available, the newly-dated horse specimen has created a slightly clearer picture regarding the age of the horse assemblage at the site. However, due to its unknown provenance and association with the site's other material, this specimen does not clearly indicate an age for the rest of the assemblage even though the non-horse fauna (e.g. bear, wolf, lemmings) could also correspond to common Middle or Late Devensian assemblages. The only reliable date obtained lies within the Middle Devensian (c. 28,900 BP), close to the limit for finite dates. This date appears to place at least part of the assemblage (presumably including horse) within the Late Pleistocene (presumably Devensian), a suggestion which agrees with Gilbertson and Hawkins' (1974) claim that the deposits at Clevedon accumulated during the Devensian. Unfortunately, one of the two specimens chosen for dating (a cut-marked tooth) failed to produce a date due to a lack of collagen. This specimen, as well as providing another horse date for the site, could have directly dated the human presence and association with the horses at the site Clearly, more direct dates are necessary in order to confirm the presence of a Mid-Late Devensian faunal assemblage (and possibly human presence) at Clevedon.

- Late Glacial/early Post Glacial

Several key points can be made regarding the impact of the current dating project on the existing radiocarbon record for this period Not only has this project provided new horse dates, it has yielded the first radiocarbon dates (all of which are Late Glacial) for particular sites (e g Moughton Fell, Wolf's Den, Neale's Cave)

which previously had no dated material. Also, those sites which had associated or general site dates (e.g. King Arthur's Cave), but no horse dates, now have newly dated Late Glacial horse material. In some cases, a conscious attempt was made to provide multiple dates (i.e. dates on 2 or more specimens) in order to obtain a clearer picture of the chronological record for horses at specific sites (e.g. King Arthur's Cave [4 dates], Fox Hole Cave [4 dates], Flixton II [2 dates]: see table 4.5). Interestingly, however, a few of the Late Glacial/early Holocene sites (e g. Victoria Cave, Dog Hole Fissure, Thatcham: see gazetteer) have yielded new dates which are unexpectedly later Post Glacial (table 4.5). These dates arose through an attempt to test for further presence of horse during the Late Glacial/early Post Glacial, but evidence of stratigraphical uncertainties at sites such as Thatcham and Dog Hole has highlighted their significance in an unexpected way. These younger dates will be discussed below (see 'middle to late Holocene' section) in more detail. In addition, an important aspect of this dating project is to provide new dates for material from sites with existing horse dates in order to augment and enhance the record as well as to confirm the presence of horse at the site during the Late Glacial/early Post Glacial. For example, two new dates each are available for Robin Hood's Cave and Mother Grundy's Parlour, two sites which had existing horse dates in addition to a number of associated or general site dates. See below for a further discussion of the horse dating in relation to previous dating for these and other sites. Interestingly, however, an attempt to confirm the presence of Late Glacial horses at one site (Kendrick's Cave) failed; and instead, two new dates (table 4.5) have produced later Post Glacial dates (c. 1,000 BP and c. 200 BP). The key factor is that these dates neither correlate with the previous Late Glacial one (c. 10,000 BP) nor the previous non-horse dates listed in Appendix 1 (see fig. 4.12).

New dates for this period total 27 and represent 17 sites (table 4.5 and Appendix 1). Figure 4.13 shows that, on their own, these dates primarily span the Late Glacial period c. 13,300-10,000 BP; however, significantly, no new dates can be added to the present record for the period between c. 10,000-8,000 BP Despite this, they provide original, positive evidence supporting the continual presence of horse during this environmentally turbulent period.

Previously, the limit at the older end of the chronological scale for the distribution of horses reached c 12,900 BP. A new date from King Arthur's Cave (table 4 5 and fig 4.14) now extends their distribution further back to between c. 13,500-13,000 BP. Despite this breakthrough, however, there is still a notable gap pre-

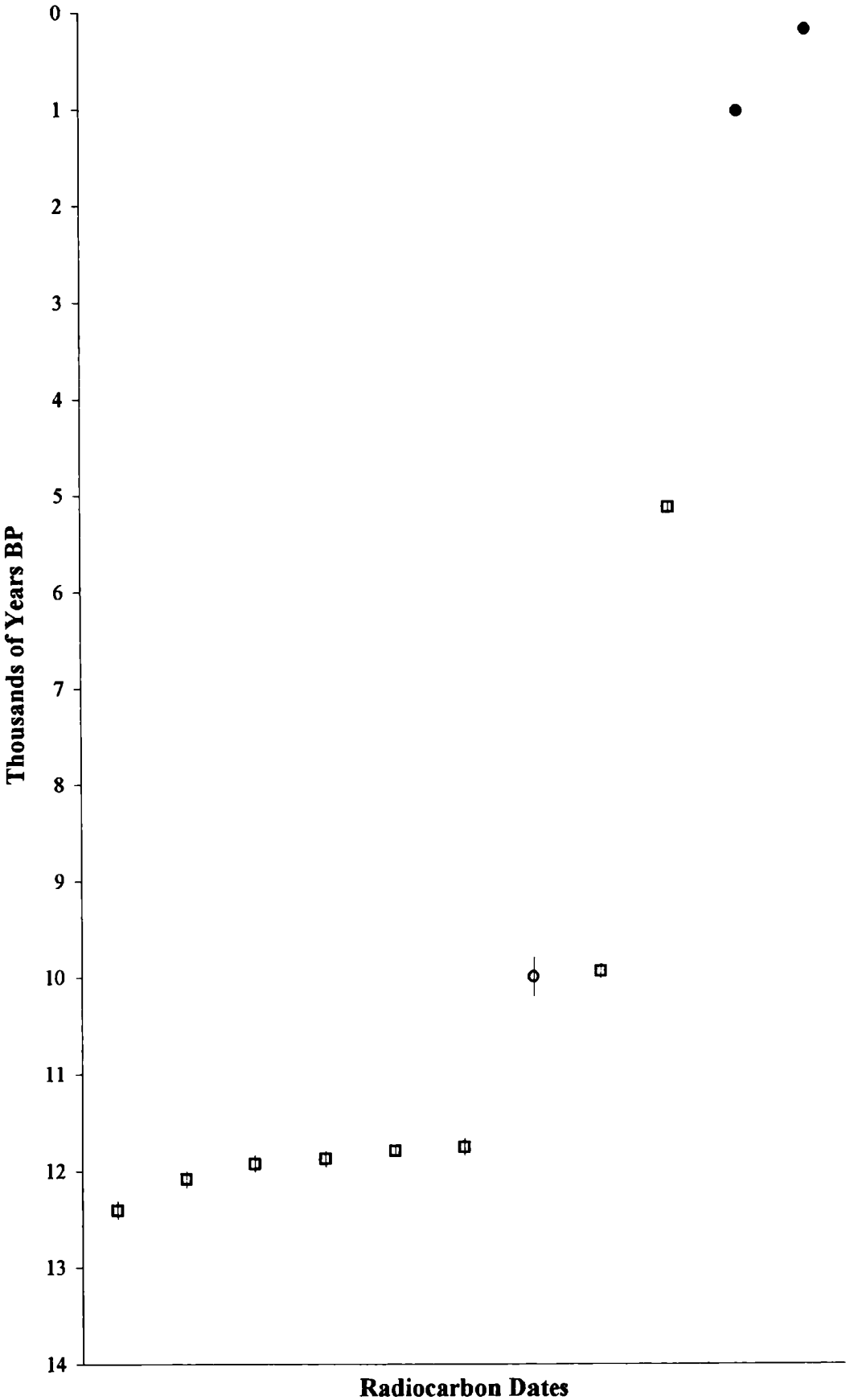

Fig 4.12. Radiocarbon record for horse and non-horse from Kendrick's Cave, Wales. (± error bars are shown with open circle= previous horse date, closed circle= new horse date; square= non-horse date).

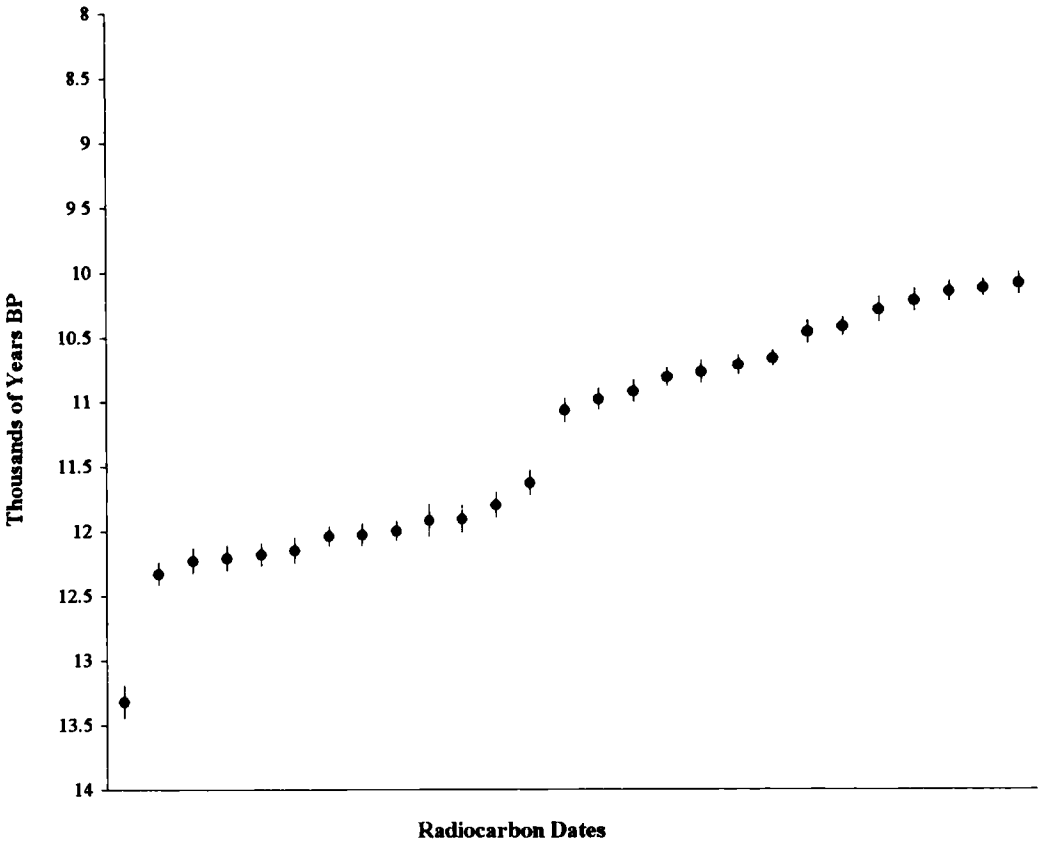

Fig. 4.13. Late Glacial/early Post Glacial radiocarbon record for British horses showing new dates only. (± error bars shown with: closed circle new date).

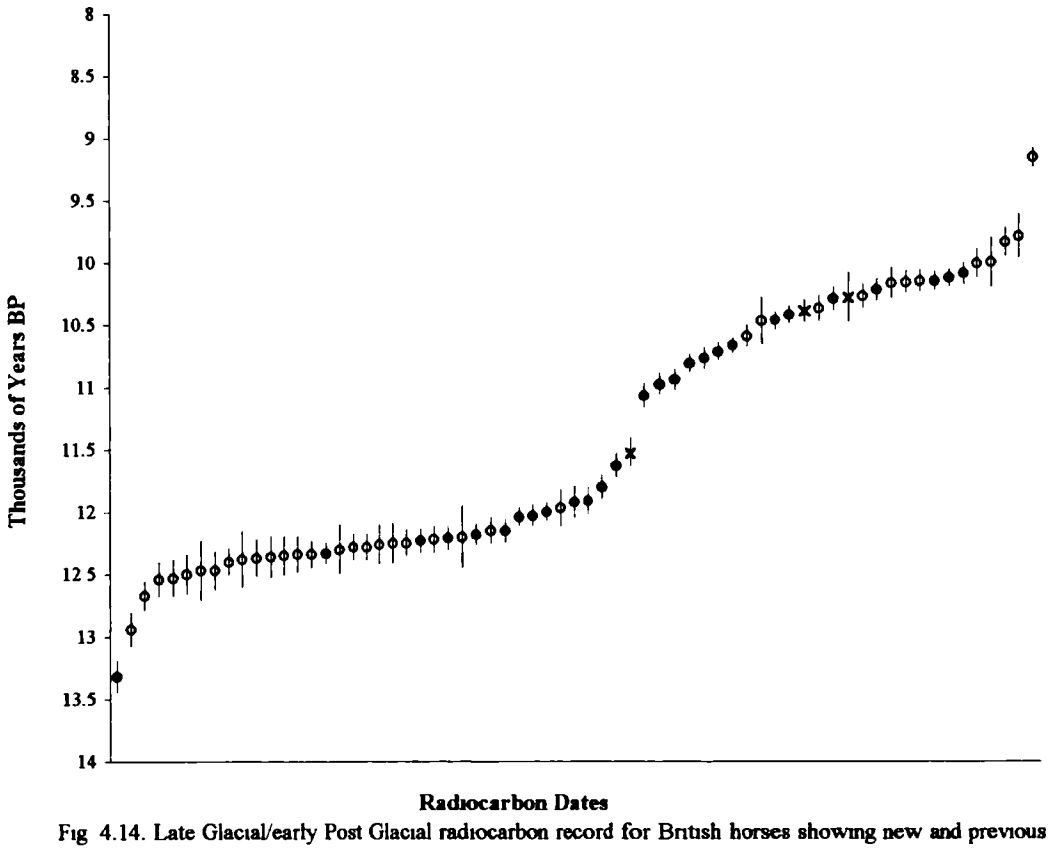

Fig 4.14. Late Glacial/early Post Glacial radiocarbon record for British horses showing new and previous dates (± error bars shown with open circle– previous horse date, closed circle– new horse date; cross unreliable date)

13,500 BP which corresponds with the end of the cold Dimlington Stadial (or "Oldest Dryas") Furthermore, it is necessary to mention two sites (Thor's Fissure, Little Hoyle) with uncertain Late Glacial horse, for which no new dates were obtained. It is possible that the assemblages from these two sites may instead date to the crucial period before the Late Glacial Interstadial (i.e. close to the date of the glacial maximum: c. 22,000-18,000 BP). Interestingly, both of these sites have existing associated/site dates (Appendix 1 and gazetteer in section 4.3.2) which place their assemblages within this pre-Late Glacial period. Ultimately, future dating projects incorporating material from sites such as these could provide the evidence needed to extend the chronological distribution of the horse beyond c. 13,300 BP to partially fill in the gap between this date and the youngest ones of the Middle Devensian (c. 27,600 BP for Ireland and c. 28,900 BP for Britain: see Appendix 1).

The continuity during the Bølling (c. 13,000-12,000 BP) was never in doubt (fig. 4.7), and new dating has served to enhance the record during this interval (fig. 4.14), especially during the latter half (i.e. c. 12,200-12,000 BP). It is in the period post-12,000 BP when the new dates make a substantial impact on the existing Late Glacial radiocarbon record. For example, previously, there was an apparent absence of horse (i.e. a wide gap) in the British record from c. 12,000-10,700 BP, and now 15 new dates almost completely fill in this gap from c. 12,000-11,500 BP with eight dates from four sites and from c. 11,200-10,700 BP with seven dates from six sites (fig. 4.14). Interestingly, however, the evidence for the presence of horses during the c. 300 year gap from c. 11,500-11,200 BP is still missing. It may be significant that this gap, although short, takes place within the latter part of the Allerød Interstadial. For a further discussion of the importance of this evidence as well as the impact of geographical and environmental factors on the radiocarbon record for horse see sections 4 6 and 4.7 later in this chapter

Not only has the new dating of the current project added to the continuity in the Bølling, but the Younger Dryas record has benefited substantially (fig 4.14). Previously, the Younger Dryas period was underrepresented chronologically compared with the Bølling so newly dated Younger Dryas horses have solidified their presence in Britain during this period (c. 11,000-10,000 BP) There are now 23 reliable Younger Dryas dates, whereas, previously, there were only nine. Furthermore, not only do the extra dates enhance the radiocarbon record, they provide direct dates for specimens whose morphology can now be confidently compared with other dated specimens from

different periods within the Late Glacial/early Post Glacial. See chapter 5 for a further discussion of this topic.

It is clear from figure 4.7 that intensive dating was needed around the edges of the gaps (i.e. c. 12,000 BP, c. 11,000 BP, c. 9,100 BP) in order to help reveal limits and/or extend continuity. Figure 4.14 shows that the new dating has achieved this for the periods around c. 12,000 BP (i.e. Bølling/"Older Dryas"/Allerød) and c. 11,000 BP (i.e. Allerød/Younger Dryas), but not for the early Post Glacial period around c. 9,100 BP (i e. the Pre-Boreal). Attempts so far to obtain early Post Glacial dates for supposed early Holocene material have failed to extend the continuity during and beyond this period; and the limit appears determined at this, the older, end of the large gap from c. 9,100 BP to c. 3,900 BP. Also, a notable gap in the record is still evident from c. 9,600-9,100 BP (see fig. 4.14). Efforts were made in the current project to date horse from sites (e.g. Thatcham) supposedly stratified within early Post Glacial deposits (i.e. Pre-Boreal/Early Boreal: c. 10,000-9,000 BP); however, unexpectedly, dates came out either Late Glacial (i.e. c. 13,000-10,000 BP) or later Post Glacial (i.e. c. 300 BP as was the case with Thatcham [OxA-6658]). See below for further details of sites (e.g. Mother Grundy's Parlour, King Arthur's Cave) with horses possibly dating to the Later Boreal (c. 9,000-7,500 BP). Clearly, the provenance of individual specimens is not as secure as was first thought or was indicated in the literature; and thus, newly obtained dates serve as evidence of stratigraphical inconsistencies at particular sites. However, the importance of the recently obtained date for horse from Flixton II must not be underestimated. This key date of 9,160 ±80 BP (OxA-6329: Appendix 1), obtained by P. Rowley-Conwy (pers. comm.), extends the range of chronological distribution from the existing date from Seamer Carr of 9,790 ±180 BP (BM-2350. Appendix 1), thus indicating Flandrian persistence of horses c. 600 years beyond the previous limit (fig. 4.14). It is evident that in the future, additional dating may be necessary in order to define the Pre-Boreal/Early Boreal limits further.

Not only are the new dates valuable as direct evidence of presence of horses at individual sites during the Late Glacial, they, in conjunction with the existing horse dates, can be compared to the associated or general site dates (Appendix 1) in order to attain a more complete radiocarbon record for those sites Again, these comparisons may provide additional data regarding such issues as the reliability of stratigraphical sequences Concerning the new horse dates from each site, four possible scenarios are evident: 1) They lie within one period of the Late Glacial/early Post Glacial and

correlate well with a particular site's previous horse and associated or general site dates; 2) They are divided between two or more periods within the Late Glacial/early Post Glacial and correlate well with previous horse and associated or general site dates; 3) They correlate well with previous horse dates, but not associated or general site dates or vice versa; and 4) They do not correlate well with either previous horse or associated or general site dates (i.e. they represent a period not covered by those dates). The majority of sites listed in the gazetteers have new dates which conform to scenarios (1) and (2) (e.g. Ossom's Cave, Chelm's Combe, Robin Hood's Cave). The new horse dates from both Ossom's and Chelm's fit well with the previous Younger Dryas dates (figs. 4.15a and 4.15b, respectively); however, the two dates from Robin Hood's, even though they correlate well with previous dates, are split between the Bølling and the Younger Dryas periods (fig. 4.8d). A good example of how a radiocarbon record can be enhanced by new faunal dating is Robin Hood's Cave where the Late Glacial horses are clearly shown to be associated with two differently-aged assemblages.

Only a small number of sites listed in the gazetteers have new dates which conform to scenario (3) (e.g. Mother Grundy's Parlour) or (4) (e.g. Aveline's Hole, Dead Man's Cave). In the case of Mother Grundy's (fig. 4.8c), the new dates correlate with existing associated/site dates better than they do with the existing horse dates during the latter stages of the Bølling. On the other hand, new dates from Aveline's Hole (fig. 4.15c) and Dead Man's Cave (fig. 4.15d) appear to represent periods (i.e. Younger Dryas and Allerød, respectively) not covered by the previous non-horse dates at each site. This is clear at Dead Man's Cave; however, at Aveline's Hole it is possible that the previous reindeer date of 9,670 ±110 BP (OxA-802) may be an underestimate of an older, Younger Dryas date due to a radiocarbon plateau (Housley, 1991; Becker and Kromer, 1991). Thus, this date may be closer chronologically to the new horse date of 10,220 ±90 BP (OxA-6671) making a total of three distinct, radiometrically dated assemblages: the two (i.e. one Late Glacial and one early Post Glacial) which Jacobi (1987) suggested, plus an additional intermediate (i e. later Late Glacial) one which Savage (1969) indicated was possibly present at the site.

Furthermore, there are three sites (i e. Fox Hole Cave, King Arthur's Cave, and Sproughton) which have yielded new dates that can be considered to be a combination of scenarios (1) (2) and (4) (i e not all the new dates correlate with the previous non-horse dates). For example, at Fox Hole (fig 4 15e) and King Arthur's (fig 4.15f) some

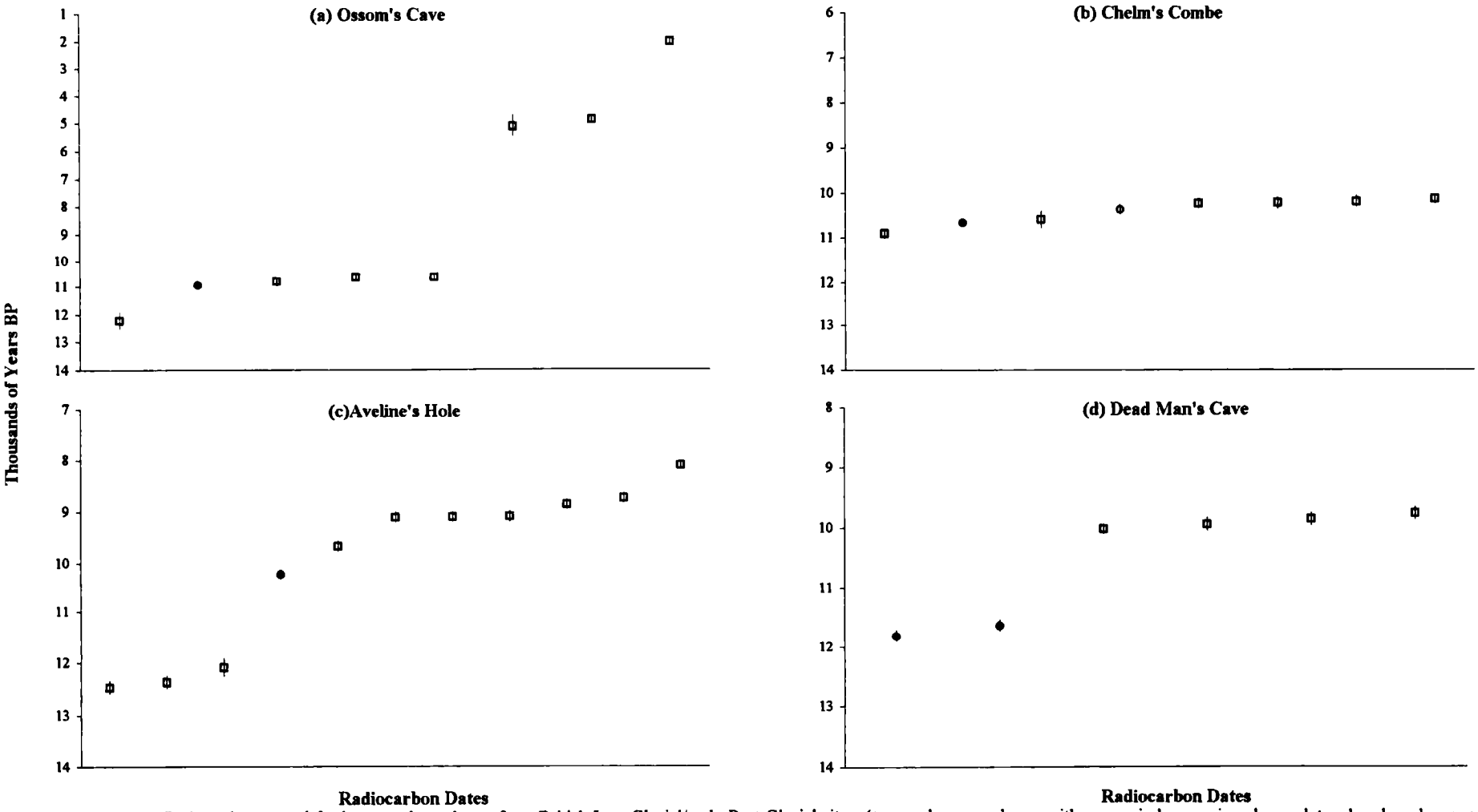

Fig 4 15(a-d) Radiocarbon record for horse and non-horse from British Late Glacial/early Post Glacial sites. (± error bars are shown with: open circle previous horse date; closed circle– new horse date; square– non-horse date).

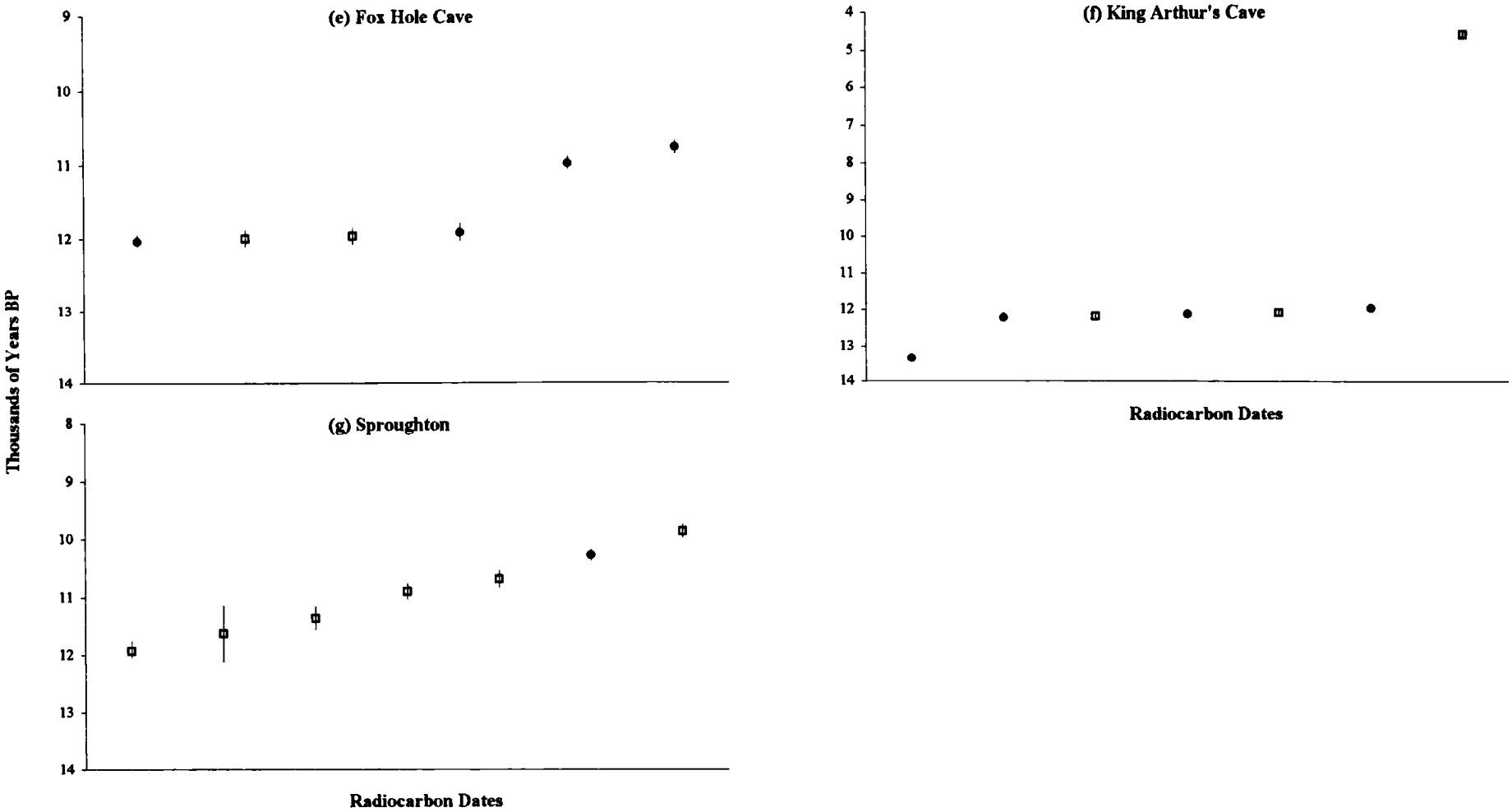

Fig 4 15(e-g) Radiocarbon record for horse and non-horse from British Late Glacial/early Post Glacial sites. (± error bars are shown with closed circle– new horse date; square– non-horse date)

of the new dates appear to represent periods not already denoted by previous dates, while the other new dates correlate well with the associated or general site dates. Moreover, in the case of Sproughton (fig 4.15g), the one new horse date seems, instead, to fill a gap in the chronological sequence at the site. However, due to the uncertain provenance of this dated specimen, it is not possible to determine whether the horse remains at Sproughton are sufficient to fill all the gaps in the complicated stratigraphical sequence at the site. The Sproughton faunal assemblage is in need of further dating to clear up these discrepancies.

It is also necessary to mention the evidence for human association in relation to the newly dated specimens. Until now, five cave sites (i e. Gough's Cave, Kendrick's Cave, Kent's Cavern, Mother Grundy's Parlour, Three Holes Cave), had provided Late Glacial dates (Appendix 1) for specimens with unequivocal evidence of human association (e.g. cutmarks, humanly broken, engravings). As a result of this project, newly-dated specimens (one from Kent's Cavern and at least one from King Arthur's Cave) can now be added to the list of humanly modified radiocarbon dated horse specimens. Taken together, these dates all range within the Late Glacial; however, not all come from a single time interval (fig. 4.16). For example, the Gough's, Kent's, Mother Grundy's, King Arthur's and Three Holes specimens all date to c. 13,000-12,000 BP (i.e. within the Bølling) and the Kendrick's specimen dates to c. 10,000 BP (i.e. just within the later Younger Dryas). Also, a case can be made for specimens from the open site of Uxbridge which date, like that of Kendrick's, to within the Younger Dryas (c. 10,300-10,000 BP). Although these specimens did not show clear signs of human modification, they were found in close association with a LUP/Mesolithic artefact scatter (see gazetteer: section 4.3 2). On the other hand, Housley (1991) notes that it is more secure to rely on dated specimens with clear evidence of human modification than what he refers to as "potentially dubious associations between tool assemblages and dated fauna".

- Middle to late Holocene (Late Mesolithic/Neolithic/Bronze Age and later):

A few key points can be made regarding the impact that the current dating project has made within this period (including both Middle and later Holocene). As a result of this project, two sites which previously had no radiocarbon dating evidence at all, now have one horse date each. However, both these dates (from Woolwich Green and Swaffham Fen) lie within the later Post Glacial (c. 1,500 BP and c 600 BP,

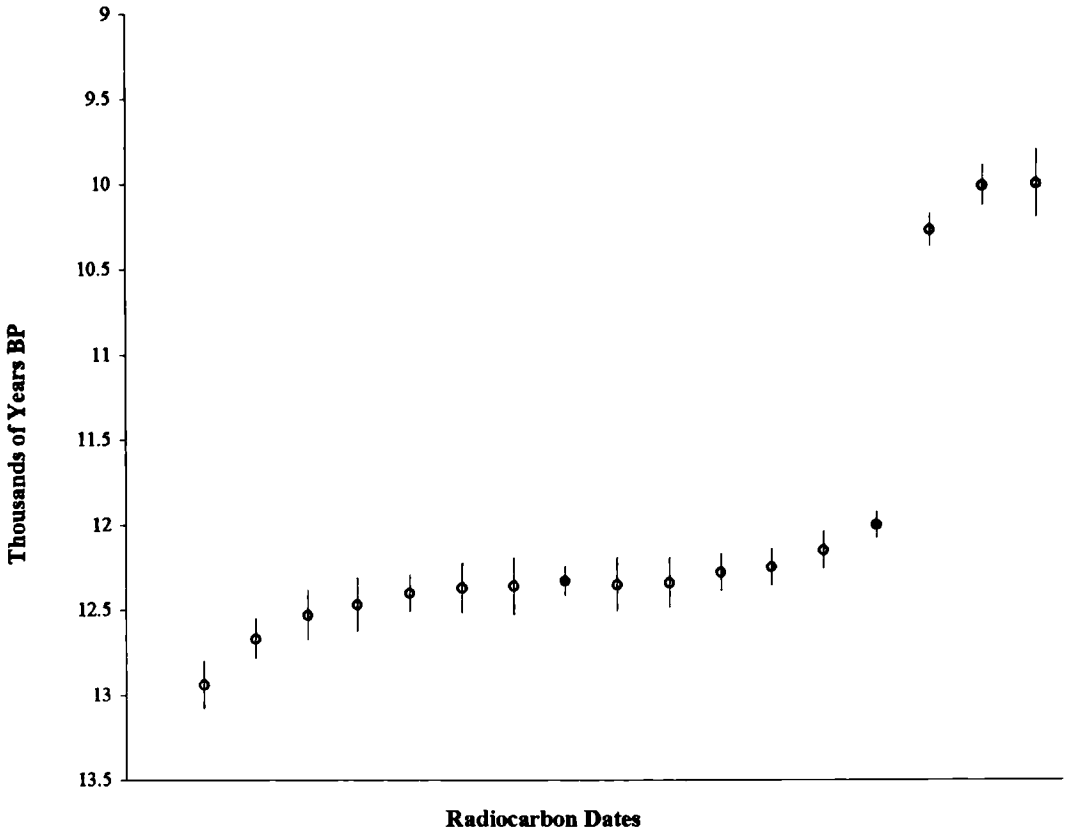

Fig. 4.16. Horse specimens with human association dated to the British Late Glacial. (± error bars shown with: open circle= previous date; closed circle= new date).

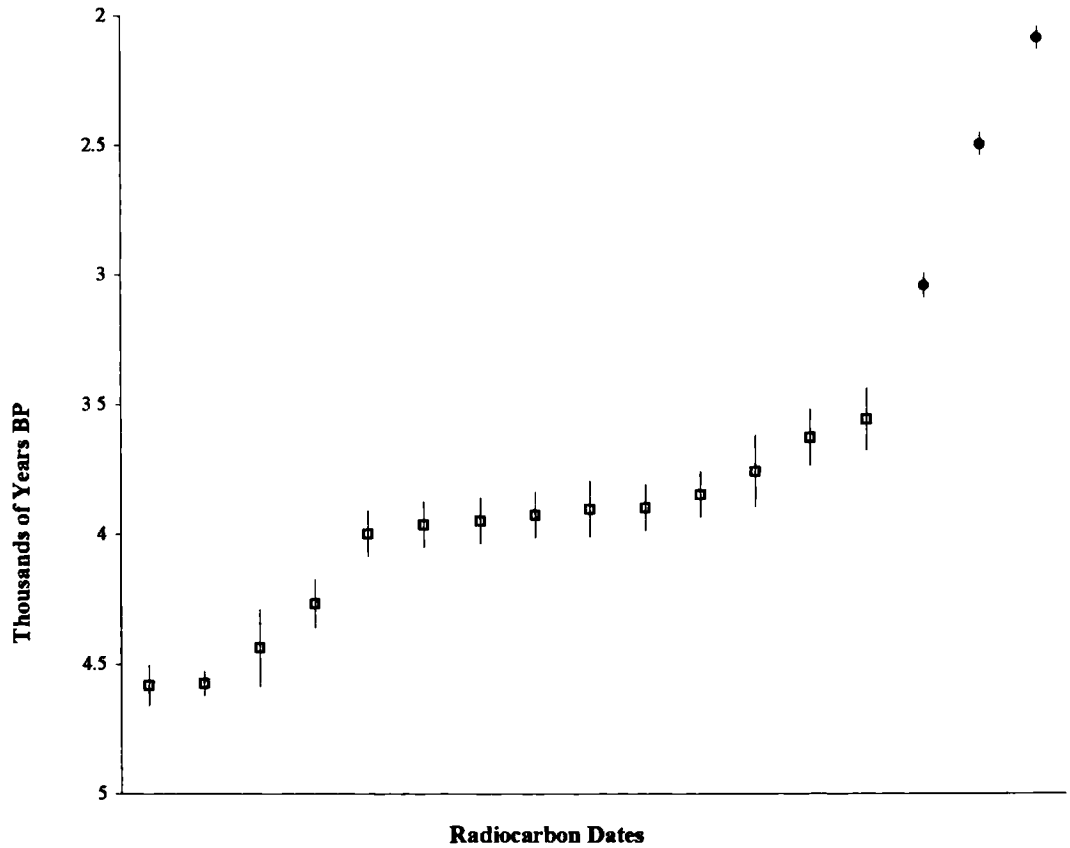

Fig 4.17 Radiocarbon record for horse and non-horse from Durrington Walls, Wiltshire (± error bars are shown with closed circle= new horse date; square= non-horse date)

respectively) rather than the middle Holocene as was expected. For example, although Swaffham Fen had no clear recorded stratigraphy, other analyses (e.g. pollen studies) at nearby sites indicate that the Fen faunal material dates to within this period (c. 7,000-2,000 BP). Representing another scenario is the recent excavation at Woolwich Green which, instead, provided a secure stratigraphical sequence in which horse remains appeared to be well provenanced within a tufaceous marl deposit possibly dating to the Atlantic (zone VIIa, c. 7,500-5,000 BP) climatic phase (A. Currant, pers. comm.). Both these scenarios exhibit the importance of radiocarbon dating studies in providing positive, sometimes unexpected, solutions to complex biostratigraphical problems.

Another key point is that three British sites (Fussell's Lodge, Durrington Walls, Maiden Castle) which previously only had associated or general site dates, now have new Holocene horse dates as a result of the current project. Interestingly, these Neolithic sites are all similar in that the true provenance of the individual horse specimens remains unclear. Thus, dating was necessary in order to clear up confusion regarding the suspected age of these important remains However, all of the new determinations obtained date unexpectedly within a later period (i.e. later Bronze Age: c. 3,100 BP, and later). Furthermore, it is necessary to stress that the multiple dating at two of the three sites mentioned above (i.e. Durrington Walls [3 dates] and Maiden Castle [2 dates]) has made an impact by providing an age range, rather than a single date, from which to work. For example, at Durrington Walls, the three dates obtained are clearly spread out (i.e. each c. 500 years apart) within the later Bronze Age/Iron Age period, c. 3,100-2,100 BP (fig 4.17).

In total, there are 16 new Holocene dates which range from c 3,100-160 BP (table 4 5 and fig 4 18), and these can be separated further into two periods. Dates for the key Holocene period (i.e. c. 9,000-2,000 BP) range from c. 3,100-1,700 BP and comprise eight reliable dates from six sites (five British and one Irish), while dates for the later Holocene period (i.e. post-2,000 BP) range from c. 1,600-160 BP and comprise eight reliable dates from seven sites (all British) It must be pointed out that many of the new dates which lie within the later Holocene range were unexpected. For example, for the five later Post Glacial dates obtained from four sites (Kendrick's Cave, Victoria Cave, Thatcham, Dog Hole), it was expected that the horses were part of their respective Late Glacial or early Post Glacial faunal assemblage based on associated finds, stratigraphy or previous dating

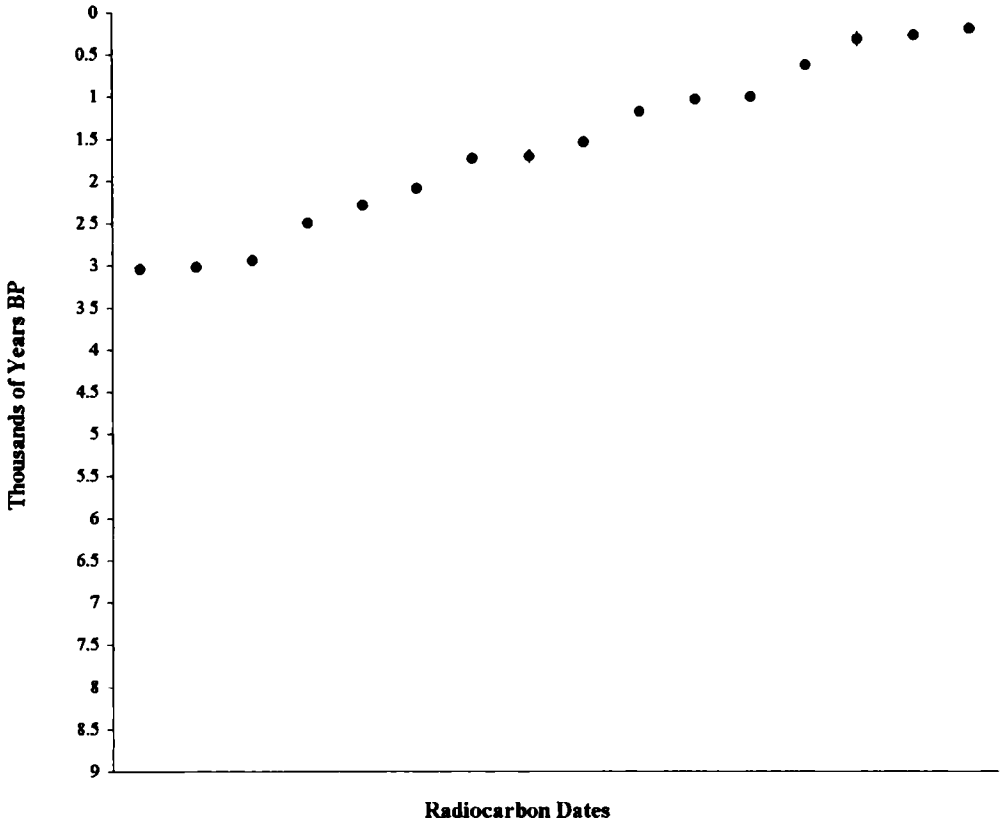

Fig. 4.18. Post Glacial radiocarbon record for British/Irish horses showing new dates only. (± error bars shown with: closed circle– new date).

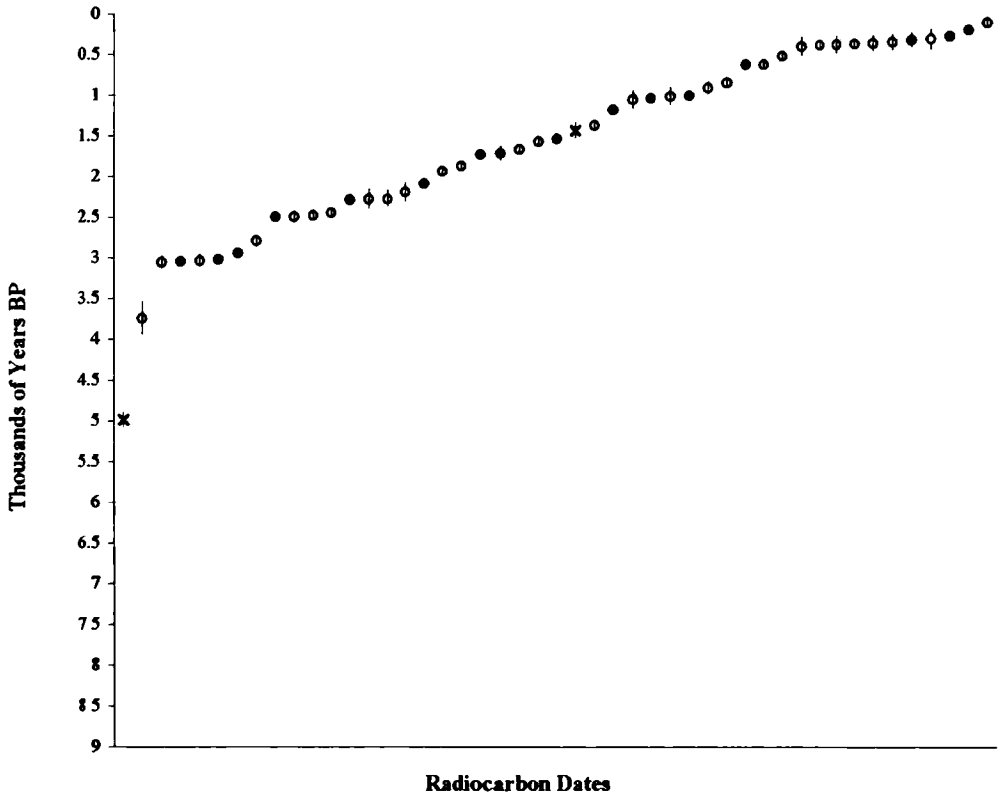

Fig. 4.19. Post Glacial radiocarbon record for British/Irish horses showing new and previous dates (± error bars shown with open circle– previous date; closed circle– new date; cross unreliable date).

Attempts were made in the current project to fill in the gap of c. 9,000-4,000 BP (see above) by dating material from middle Holocene sites to test whether there was continual presence of horses in Britain from the Late Pleistocene to middle and late Holocene or local extinction during the early Holocene and later reintroduction in the middle Holocene. Particular sites (King Arthur's Cave, Mother Grundy's Parlour, Gough's Cave, Fussell's Lodge, Maiden Castle, Durrington Walls) were singled out as having yielded horse material which potentially bridged this gap. All six sites have existing dating, stratigraphical and artefactual information which suggests that the horse at each site dates to within this interval. For example, deposits with horse finds at both King Arthur's Cave (First Hearth) and Mother Grundy's Parlour (Layers B, B/C and C) are thought to date to the Later Boreal (Mesolithic) and Atlantic (later Mesolithic/Neolithic) periods based on tool forms and radiocarbon dating evidence (Grigson, 1978). However, the new dates obtained for specimens from these Holocene levels do not fall within either of these periods Instead, they correlate well with the other new and existing Late Glacial dates available for horse from these sites. It is now clear that some mixing between Pleistocene and Holocene deposits must have taken place. On the other hand, at Gough's Cave, another Late Glacial site with Holocene deposits including horse, the newly obtained later Post Glacial date (c. 1,200 BP: table 4.5) was not so surprising as the specimen's recorded provenance (i.e. post-Pleistocene Layer 5) and small size suggested that it was of middle Holocene age or younger. Also, it is necessary to mention the unsuccessful attempt by the author to find and date the horse remains from Wawcott XXIII (see gazetteer: section 4.3.2), another site which, according to Grigson (1978), is thought to date to the Atlantic (zone VIIa: later Mesolithic).

With regard to new horse dates obtained from the Neolithic sites of Fussell's Lodge, Maiden Castle and Durrington Walls, it must be noted that these also fall outside the c. 5,000 year gap, but at the younger limit. In each case, either Neolithic or Early Bronze Age dates were expected; instead, the dates range within the later Bronze Age/Iron Age to later periods (c. 3,100-1,000 BP) Thus, despite these attempts to extend the distribution within the Holocene, the picture is reinforced with regard to the gap from c 9,000-4000 BP (i e. no new dates are available close to the 4,000 BP limit or earlier) (figs. 4.9 and 4.19). On the other hand, although the new dates do not bridge this important 5,000 year gap, they do provide additional evidence for the continual presence of horse in Britain from c. 3,000 BP to Recent times (see fig. 4 19).

Again, it is important to look at the new middle Holocene or later horse dates with respect to the previous non-horse dates available in order to determine whether they correlate or not Since none of the sites from which new dates were obtained had any previous horse dates within this period, the same scenarios (1-3) for previous dates are applicable here. Thus, either the new horse dates fit in well with the previous associated or general site dates or they do not. In fact, an overwhelming majority of sites (e.g. Kendrick's Cave, Durrington Walls, Killuragh Cave, Maiden Castle) have new dates which conform to scenario (3) (i.e. they represent a period not covered by the previous Holocene associated or general site dates) (figs. 4.12, 4.17, 4.20a and 4.20b, respectively). Only two sites (Gough's Cave and Thatcham) with new Holocene horse dates conform to scenario (1) and correlate well with the previous non-horse dates. Although both dates lie within the later Holocene, figures 4 8a and 4.20c show that they agree well with the previous dates for the same later Holocene period, especially at Thatcham. Also, interestingly, some sites (e.g. Victoria Cave) which have yielded new Holocene dates had no previous non-horse Holocene dates, and thus they are novel for these sites (see fig. 4.20d), and unexpectedly late.

An interesting aspect of the current dating project, especially within this period, is the amount of human association that can be attributed to the particular horse specimens. Although there is no clear evidence whether these dated horses at the older limit (i e. c. 3,000 BP) are domestic or wild, most do come from sites with some evidence of human activity (e.g. agriculture, burials). In some cases, there is no clear evidence linking the humans to the horses in a domesticator/domesticate relationship (e g. at Durrington Walls). For a further discussion of these issues see chapter 6. On the other hand, a couple of newly dated specimens (from Gough's Cave and Victoria Cave) retain unequivocal evidence of a human association in the form of cutmarks (i.e. evidence of butchery). In the case of Victoria Cave, the specimen was chosen because the evidence of human modification on this isolated specimen suggested Late Upper Palaeolithic exploitation. Instead, however, this specimen dates unexpectedly to the later Holocene (c. 1,700 BP) On the other hand, the new Gough's Cave determination, although dating similarly to the later Holocene (c. 1,200 BP), is on a specimen from a large sample and so can be used further in comparison with the number of other specimens from the site (i e. those larger-sized specimens from the Late Glacial deposits) which also exhibit cutmarks

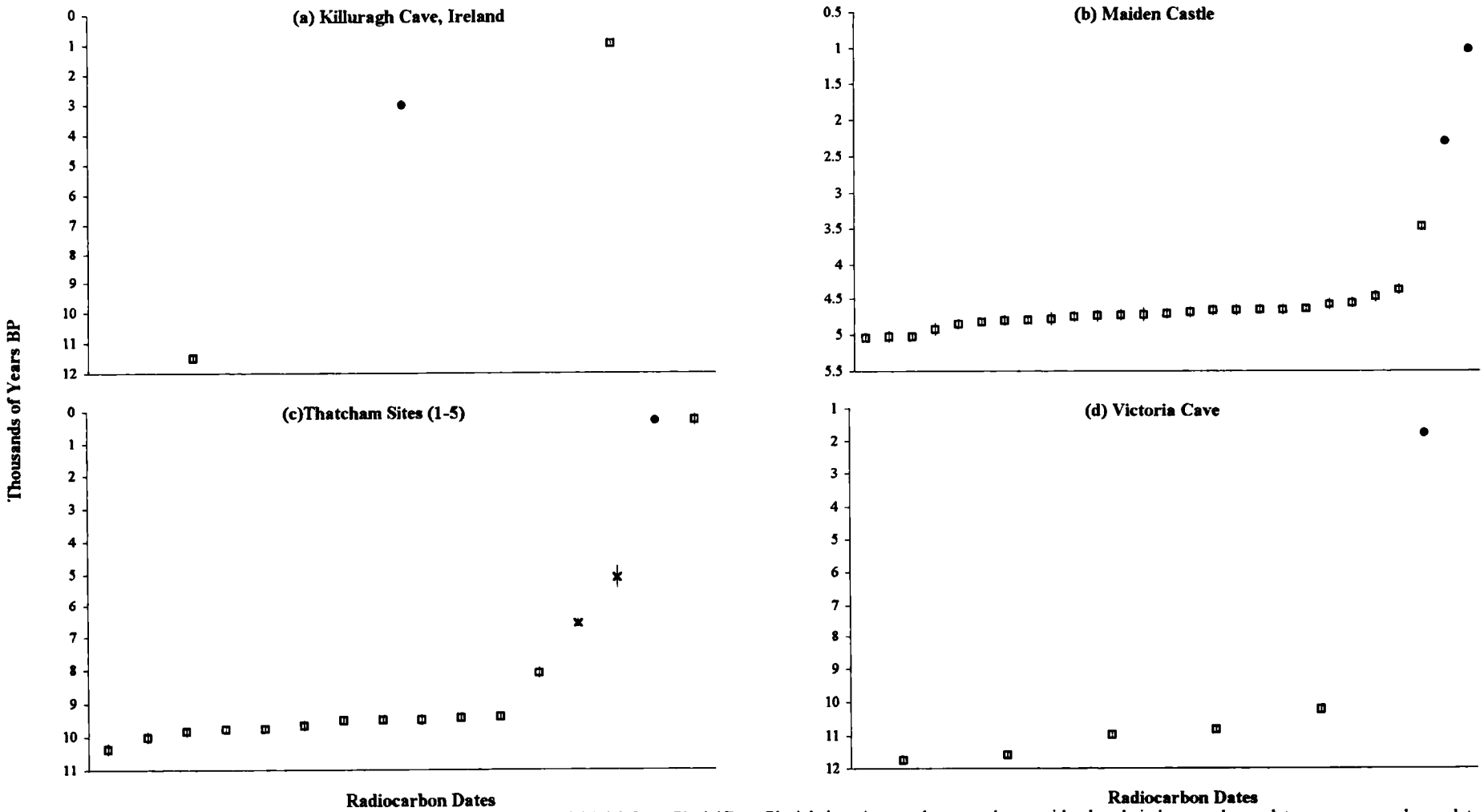

Fig. 4.20(a-d). Radiocarbon record for horse and non-horse from British/Irish Late Glacial/Post Glacial sites. (± error bars are shown with: closed circle– new horse date; square– non-horse date; cross unreliable date).

Overview and Conclusions

This section has highlighted the chronological evidence for a particular species, the horse. The present situation emphasises the importance of a sufficient number of directly (radiocarbon) dated horse fossils in order to create a more complete record of its occurrence through time Also, because the original context of individual fossils can never be known with certainty, direct dates are essential. The status of horse chronology in Britain and Ireland now that this new work is complete is as follows: in total, 116 reliable dates on horse from 64 sites are available covering the three key periods discussed above (Appendix 1).

The dating evidence for the Mid-Late Devensian period is clearly incomplete; however, the available evidence is still useful. Eight reliable dates are now available from eight separate sites (seven British/one Irish). The key point is that the majority of these dates lie within the Middle Devensian (c. 40,000-20,000 BP) and provide secure evidence for the presence of horse during this period in Britain and Ireland. Currently, however, there are no direct dates for horse which lie within the cold Dimlington Stadial period or "Full Glacial" (c. 22,000-15,000 BP). In fact, only five sites (four British/one Irish: Tornewton Cave, Little Hoyle, Thor's Fissure, Badger Hole, Castlepook Cave [Ireland]: see gazetteers) have associated or general site determinations which lie within this period; and of these five sites, the four British ones have yielded horse material which could potentially date to within this interval (i.e. they were found in Devensian deposits). Further dates are urgently needed to support a presence for horse in Britain during the Dimlington Stadial, a period considered to have been environmentally extreme (i.e. arctic conditions) (Campbell, 1977; Lowe and Walker, 1997).

There is a further point concerning the pre-Late Devensian horse chronology worth mentioning. It is notable that some sites (e.g. Windy Knoll: see section 4.3.4) dating to the Early to Middle Devensian period contain no horse. For example, even though Windy Knoll has a large collection of remains, horse is not part of the mammalian faunal assemblage. It is possible that assemblages such as this either typify an earlier period (i e pre-Middle Devensian) where horse is known to have been absent (A Currant and R Jacobi, pers. comm) or they represent some unknown interval within the Middle Devensian in which horse is lacking. According to Currant and Jacobi (1997), the former appears to be the more plausible scenario. See section

4.7 below for a discussion of the factors (e g. environment, competition) which may be associated with the absence of horses during the Mid-Late Devensian and Flandrian.

The key chronological evidence (108 reliable dates from 57 sites) comes from horses which date to the two later periods (i.e. Late Glacial/early Post Glacial and middle Holocene and later) which are highlighted throughout the current study. Particular importance is given to the new determinations (43 reliable dates from 29 sites) obtained as a result of the current project. It is evident from figure 4.21 that these dates can stand on their own as significant evidence supporting the continuous presence of horses during two distinct periods: 1) the Late Glacial to early Post Glacial (c. 13,400-9,100 BP); and 2) the middle Holocene (i.e. Late Neolithic) to Recent times (c. 3,900-60 BP). The existing Late Glacial/Post Glacial record for horse in Britain and Ireland (fig. 4.11) has changed significantly with the addition of new dates (fig. 4.22), particularly during the range c.14,000-2,000 BP. However, no new dates bridge the gap between the two intervals, and there is now a very clear signal suggesting that horses were absent in Britain throughout the c. 9,000-4,000 BP gap period (fig. 4.22). As it stands, the record upholds the theory that extinction was followed by reintroduction rather than continuity from the early Post Glacial through the middle Holocene and later. On the other hand, because the evidence presented here is negative, specimens could still turn up and yield dates which fill the gap. More importantly, however, the positive evidence presented here remains overwhelming, and seems to strongly support the suggestion (Currant, 1991) that horses achieved a greater continuity in Britain through the Late Glacial to earliest Post Glacial climatic/vegetational events than any other large mammal species (e g. elk, reindeer, mammoth, aurochs).

Although there is an apparent chronological continuity during much of the Late Glacial, a notable gap is evident at c. 11,500-11,200 BP (i.e. within the Allerød Interstadial or zone II). Despite the lack of dated horse within this interval, sites do exist which have provided non-horse material dating to the later Allerød. These include sites which have not yielded any horse material at all (e g. Broken Cavern and Dowel Cave) as well as sites (e g. Gough's Cave, Mother Grundy's Parlour, Sproughton) which have produced Late Glacial dated horses pre- and post-dating the interval in question (i e. Bølling, "Older Dryas"/Allerød and Younger Dryas, respectively). Furthermore, two other sites with horse material have produced horse dates which do not even lie within the Late Glacial (e g. Hyaena Den [Mid-Devensian] and Victoria

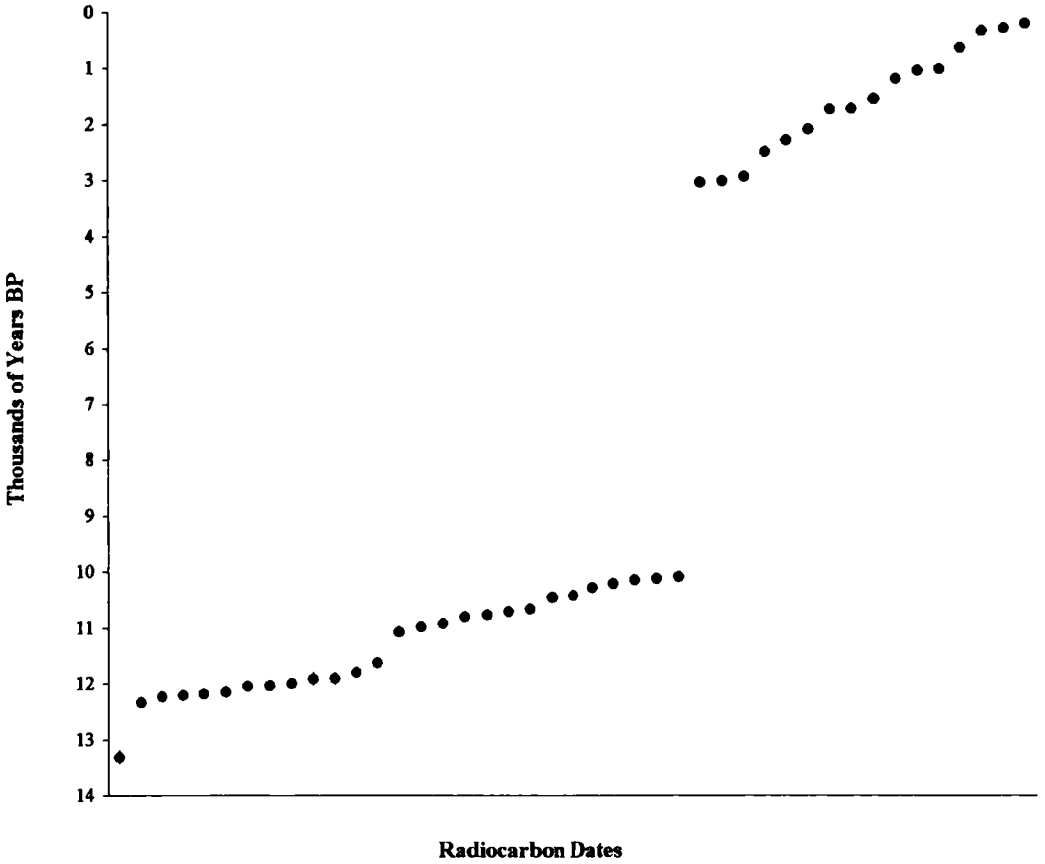

Fig. 4.21. Late Glacial/Post Glacial radiocarbon record for British/Irish horses showing new dates only. (± error bars shown with: closed circle– new date).

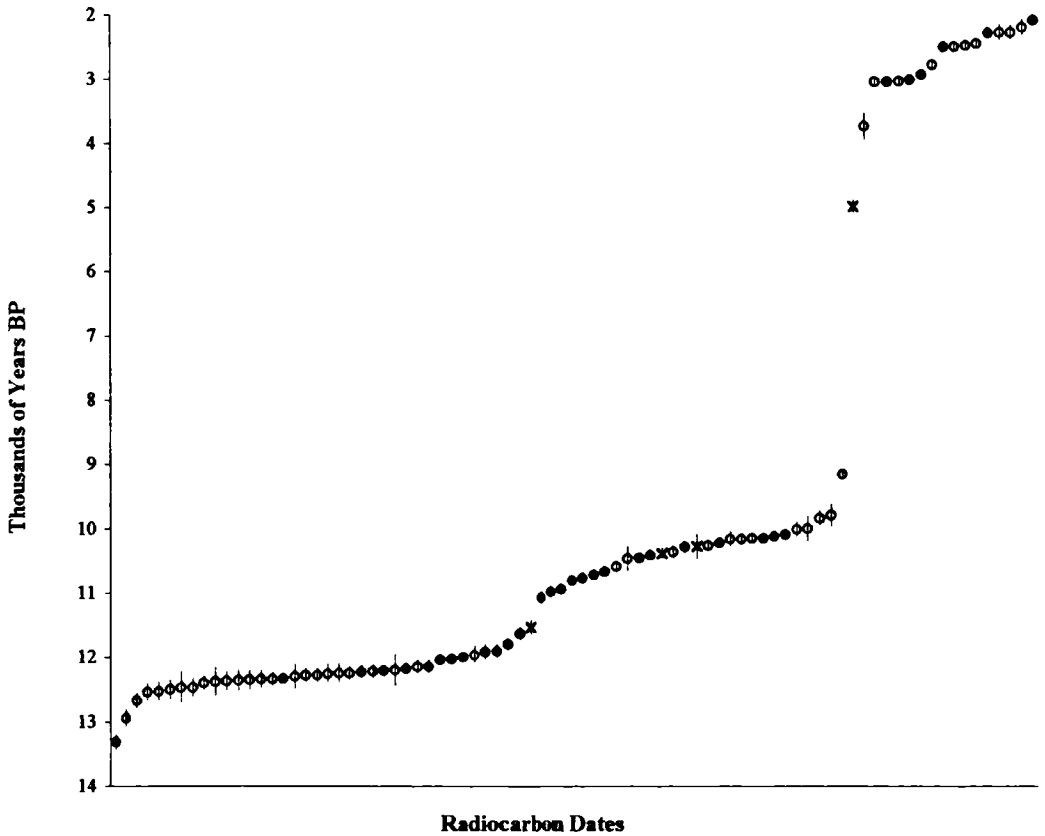

Fig. 4.22 Late Glacial/Post Glacial radiocarbon record for British/Irish horses showing new and previous dates (± error bars shown with open circle– previous date, closed circle new date, cross– unreliable date)

Cave [later Post Glacial]). Although only a short period of time (c. 300 years), this evidence seems to indicate that horses were absent in Britain during the latter part of the Allerød, a period during which climatic oscillations are thought to have occurred in the British Isles (Lowe and Walker, 1997). These oscillations could have had an effect on the distribution of horses within Britain during this time (see section 4 7 and chapter 3: section 3.3).

Furthermore, there are two key points concerning Devensian sites with horse which should be mentioned. One point deals with the fact that although some sites have yielded Late Glacial non-horse dates, their horses date solely to the Middle Devensian (e.g. Pin Hole, Hyaena Den, Elderbush Cave, Torbryan 6: see Appendix 1). There are at least five possible reasons for this scenario: 1) Collection/site problems may be to blame (e.g. inconsistent sampling and stratigraphical procedures); 2) The dated Late Glacial period may represent an interval when horse was absent or infrequent (e.g. 12,000-11,000 BP Allerød interval); 3) Other sites nearby might provide a stratigraphic correlation by having yielded Late Glacial (dated) horses; 4) Horses may not have been the favoured prey of humans and/or non-human predators; and 5) The lack of a significant sample of horse dates for each site (i.e. one horse date is often not enough).

Unlike the Late Glacial/early Post Glacial, dating of horses from middle Holocene sites has been problematic. Not only is material scarce, but available specimens are often of dubious or unknown provenance. Even the previous dates on horse for this period were not entirely convincing. Thus, the majority of new horse dates were obtained with some wariness. It was hoped that by dating material from key Mesolithic/Neolithic/Beaker sites which had also yielded other fauna dating to this period, the horse material would also oblige; however, the present work has proved that this is not the case, and the supposition (Jackson, 1943; Grigson, 1966, 1977) that because horses appear to be prevalent at Neolithic sites, then they must have flourished during this period, is inaccurate. For example, despite attempts (this project) to date material from various Neolithic sites, there is still only one secure (later) Neolithic date (i e. the existing Grimes Graves date, c 3,700 BP: see Appendix 1 and fig. 4.23) for horse. Although this date confirms the presence of horse in Britain during the later Neolithic, it cannot be considered as sufficient evidence to confirm prevalence during the Neolithic period. Furthermore, it is interesting that all attempts at dating Neolithic horses resulted in Bronze Age and later dates (e g. Durrington Walls) (see fig 4.23).

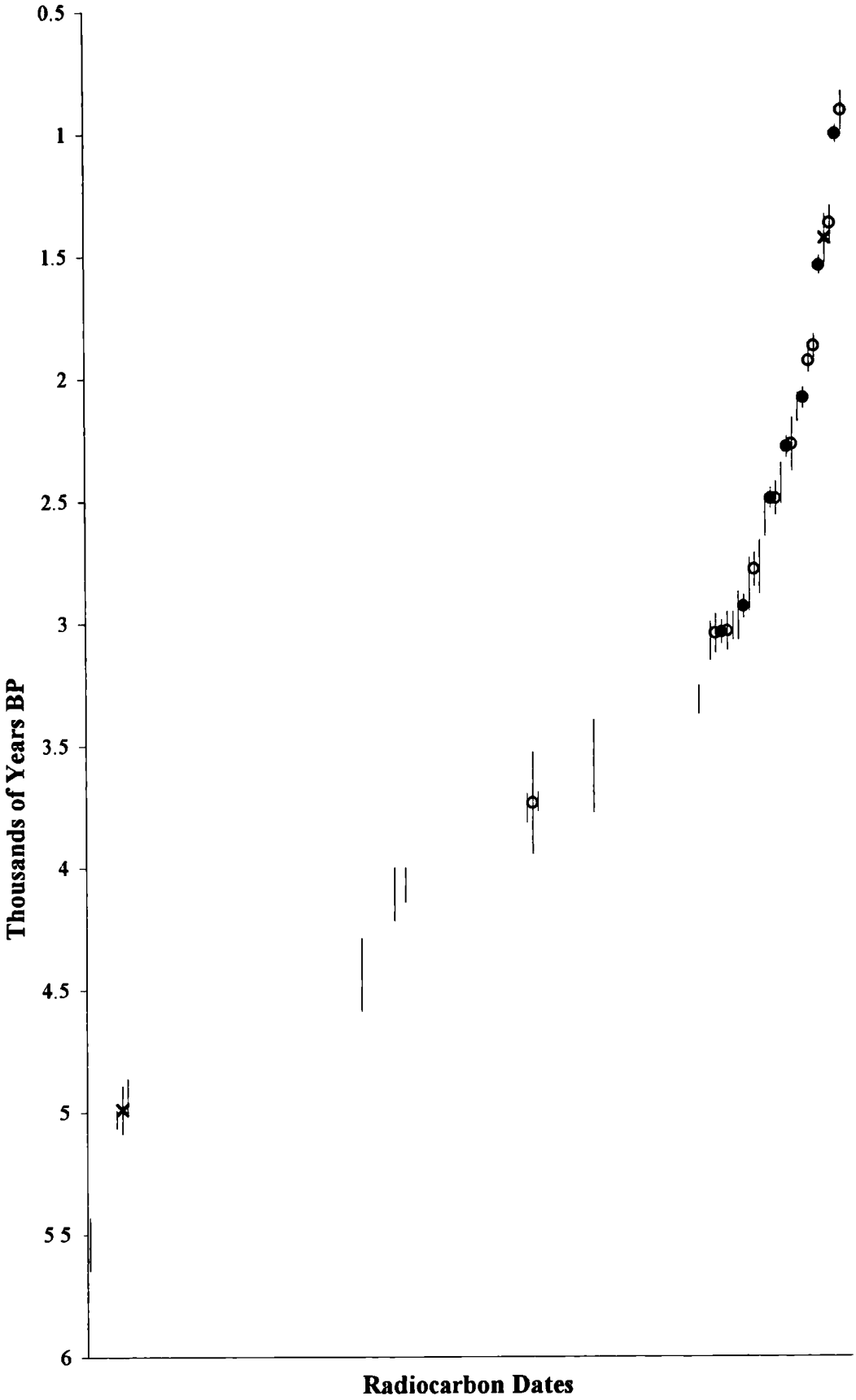

Fig. 4.23. Radiocarbon record for horse and non-horse from Neolithic/Beaker sites. (± error bars are shown with· open circle= previous horse date, closed circle= new horse date; unmarked error bar= non-horse date; cross= unreliable date).

Also, it is clear from figure 4 23 that previous associated or general site dates should be used only as a guide to the age of stratified horse remains and not as the definitive age for the horses at the site. It is possible to do this type of indirect dating at sites such as Mount Pleasant and Newgrange, Ireland (see below); however, problems are likely to arise if other considerations (e.g. morphological, geographical) are not made in tandem. In short, there is no substitute for a direct reliable date. Additionally, it is possible that at some Neolithic/Beaker sites, the horse was stratified, instead, within later (e.g. post-Beaker or Bronze Age) deposits (e g. Giant's Hills, Thickthorn Down). Thus, in the current work, the careful scrutiny of the dating and stratigraphy from relevant sites has highlighted the danger of making assumptions regarding the age of Holocene horses based on the limited information available from sites some of which were excavated over twenty years ago.

Importantly, a further mention must be made regarding the dating of sites without horse in deposits relevant to the current project: Late Glacial/early Post Glacial and middle Holocene (see section 4.3.4). It is interesting that all mentioned Late Glacial sites with non-horse dates in the key gap period of c. 11,500-11,200 BP (e.g. Dowel Cave, Kinsey Cave, Broken Cavern) contain no horse within Late Glacial levels. Again, this is further evidence (although negative) supporting an absence of horses during this later Allerød period. Also, as mentioned previously, it is significant that the early Post Glacial site of Star Carr contains no horse remains at any level. Why, at a site of this age and with a huge collection of faunal remains, is horse absent? The lack of horse at sites such as this and Broken Cavern (all Late Glacial levels) may not be as significant as it appears. Interestingly, there are alternative sites nearby each which have produced both Late Glacial (e.g. Three Holes Cave, Neale's Cave) and early Post Glacial (e g. Seamer Carr, Flixton site II) dated horse remains, thus allowing stratigraphic correlation. Also, at certain previously mentioned sites (e.g. Cherhill, Blashenwell, and Westward Ho!), horse is absent within deposits which represent intervals of the early-middle Post Glacial (e g. Boreal [zones V/VI] and Atlantic [zone VIIa]), periods in which horse was not expected to flourish due to the inhospitable climate and environment which prevailed at the time (e g. warm, wet and forested during the Atlantic) However, since many of the faunal assemblages at sites such as these are incomplete or fragmentary, again, the absence of horse may not be meaningful. For example, although horse and elk are both absent from the faunal assemblage of the Boreal deposit at Cherhill (Wiltshire), Grigson (1978) notes that

because this deposit's faunal remains are so "fragmentary" anyway, the absence of horse and elk "may not be significant". On the other hand, during the Neolithic period of the middle Holocene there are a significant number of sites (many not mentioned in section 4.3.4· e g. Nutbane, Hampshire: Morgan, 1959) at which horse is absent. This, in addition to the lack of dating evidence, may again suggest that horses were not as prevalent during the Neolithic as was originally thought. The Neolithic site of Hambledon Hill (Selkirk, 1975; Legge, 1981) serves as a good example of one which, although it yielded a large collection of faunal remains as well as site dates which lie within the Late Neolithic/Beaker (see Appendix 1), horses are altogether absent from the key deposits.

The discussion above highlights the potential pitfalls of relying exclusively on chronological evidence from sites with archaeological (or human) associations (e.g. see above: Robin Hood's Cave horse dates versus non-horse dates). For the current dating project, the author specifically sought specimens from sites (e.g. Wolf's Den) that had evidence of a non-human accumulation in order to provide a mixture of dating evidence for the clearest unbiased picture of horse distribution through time. However, the dating picture is more biased towards human association for the middle Holocene: it was difficult to find non-human accumulations due to the lack of availability. This is not to say that material without human associations was not sought by the author. For example, the Woolwich Green assemblage provided horse remains which are now dated; however, they date unexpectedly to the later Post Glacial (c. 1,500 BP).

It is possible that over the course of time, the nature of human/horse interactions changed. A further discussion of this issue can be seen in chapter 6; however, it is necessary to mention it briefly here with regard to chronological distribution of horses. It is noticeable that the intensity of human/horse interactions varied during different periods of the Late Glacial/early Post Glacial. For example, butchery evidence appears to be more prevalent during the Windermere Interstadial (Bølling) than during the Loch Lomond Stadial (Younger Dryas). In addition, there seems to be a lack of dated and cut/butchered bones (all species) within the Younger Dryas. Although four sites in particular (Kendrick's Cave, Elderbush Cave, Sproughton, Victoria Cave) have provided evidence (i e. Younger Dryas dates on humanly modified material), only one of those sites (Kendrick's) includes a directly dated horse specimen (decorated mandible). Perhaps, as a result of numerous factors, the same variation in intensity occurred during the Post Glacial period, and the outcome is the absence of horses at

particular middle Holocene sites. It is conceivable that humans were just not intensively "using" (i.e. exploiting for one reason or another) horses during certain intervals (e g. Neolithic) of the Post Glacial period and within particular areas of Britain.

At this stage in the investigation, it is evident that dating alone does not clear up the problem of the transition from wild to domestic horses in Britain. It is probable that the wide gap in the chronological distribution of horses (c. 9,000-4,000 BP) bridges this transitional phase, and thus, no signal is detectable. It is assumed that the dated horses of the Late Glacial/early Post Glacial represent the wild horse (*Equus ferus*), while the dated horses of the middle Holocene (Late Neolithic and later) represent the domestic horse (*Equus caballus*). However, the first direct evidence for domestication (e.g. horse trappings) is thought to appear during the Bronze Age (Zeuner, 1963), thus suggesting that the pre-Bronze Age horses were wild. Indeed, Harcourt (1971) considered the "Neolithic" horses of Durrington Walls to be wild based on their supposed large size (i.e. a wild trait) as well as Zeuner's theory (above). Here, the current dating project has aided the investigation. Three determinations are now available for the horses from Durrington Walls, and none date to the Neolithic. It must be noted that specimen size was the motivating factor for dating these three particular specimens, and interestingly, only one specimen (the larger of the two first phalanges, but not as large as most Late Glacial ones) has yielded a Late Bronze Age date, while the other two (a small first phalange and a radius) have yielded later dates (i.e. Late Bronze Age/Iron Age). Although the morphology of these specimens in comparison with those of known wild and domestic horses will be dealt with in detail in chapter 5, this example highlights the effectiveness of dating based on morphology as a possible alternative solution to the domestication problem. So, at Durrington Walls, because the horses date to the Late Bronze Age and later rather than the Neolithic, they are probably domestic horses, however, the lack of direct domestication evidence highlights the uncertainty regarding their true status.

Finally, it is necessary to summarise the Irish chronological evidence presented in the current work. The extant record includes eight dates from eight sites, one of which (Killuragh Cave) was obtained by the author in collaboration with P. Woodman. The other seven dates were obtained by Woodman *et al.* (1997) as part of the 'Irish Quaternary Fauna Project' which set out to date a range of fauna from both cave and open sites in Ireland. The present author believes the most significant of these dates to

be the oldest, Mid-Midlandian (= Mid-Devensian), one of c. 27,600 BP (from Shandon Cave) because it refutes the claim made by various authors (e g. Clutton-Brock and Burleigh, 1983, 1991; Clutton-Brock, 1986) that no fossil horses existed in the Pleistocene of Ireland. Significantly, however, no dates are available for horse from any interval of the Irish Late Glacial, and the next oldest date appears in the mid-late Holocene at Killuragh Cave (c. 3,000 BP). It appears that, because of the scarcity of horse material and in turn dates, many more (and wider) gaps are evident in the Irish record (fig. 4.24) than in that of Britain (fig. 4.25). For example, why were horses completely absent from the Late Glacial in Ireland (i.e. the Woodgrange Interstadial and the Nahanagan Stadial), when in Britain they were so prevalent during this period? Woodman *et al.* (1997) describes this phenomenon as an "enigma"; however, there must have been additional environmental/ecological reasons for the complete absence of horses in Ireland during the Late Glacial. These will be discussed in more detail later in this chapter (section 4.7).

In particular, one of the remits of the Woodman *et al.* (1997) project was to investigate whether horse had reappeared in Ireland before 4,000 BP (i.e. pre-Beaker) by dating the various discoveries which have accumulated over the years (e.g. Scharff, 1908-9; Doughty, 1969; Woodman, 1978). Interestingly, six of these sites have yielded dates (Appendix 1) which are all unexpectedly young (i.e. later Post Glacial). As indicated above, only the new date from Killuragh Cave (table 4.5 and Appendix 1) lies nearest to the critical interval of c. 4,000 BP and earlier. In fact, although other sites are thought to have middle to late Holocene (i.e Bronze Age/Iron Age) horses, this direct date happens to be the only secure evidence for horse in the pre-Iron Age period of Ireland. One notable absentee from this collection of dated discoveries is the horse material from Newgrange (see gazetteer: section 4.3.4). Although it is assumed that these date to the Beaker period based on associated dates (Appendix 1) of the deposits in which they were found (van Wijgaarden-Bakker, 1974, 1986), none of these remains has been directly dated Therefore, the author is still uncertain about their true age because, as has been seen elsewhere in this work (e.g. Fussell's Lodge, Maiden Castle), apparent secure provenance does not ensure congruity with associated or general site dates Also, it is assumed (without any positive evidence to support this) that these supposed Beaker horses were domesticated ones probably having been used for draught/riding purposes rather than for food (van Wijgaarden-Bakker, 1986) However, since no positive direct evidence is given in support of this assumption

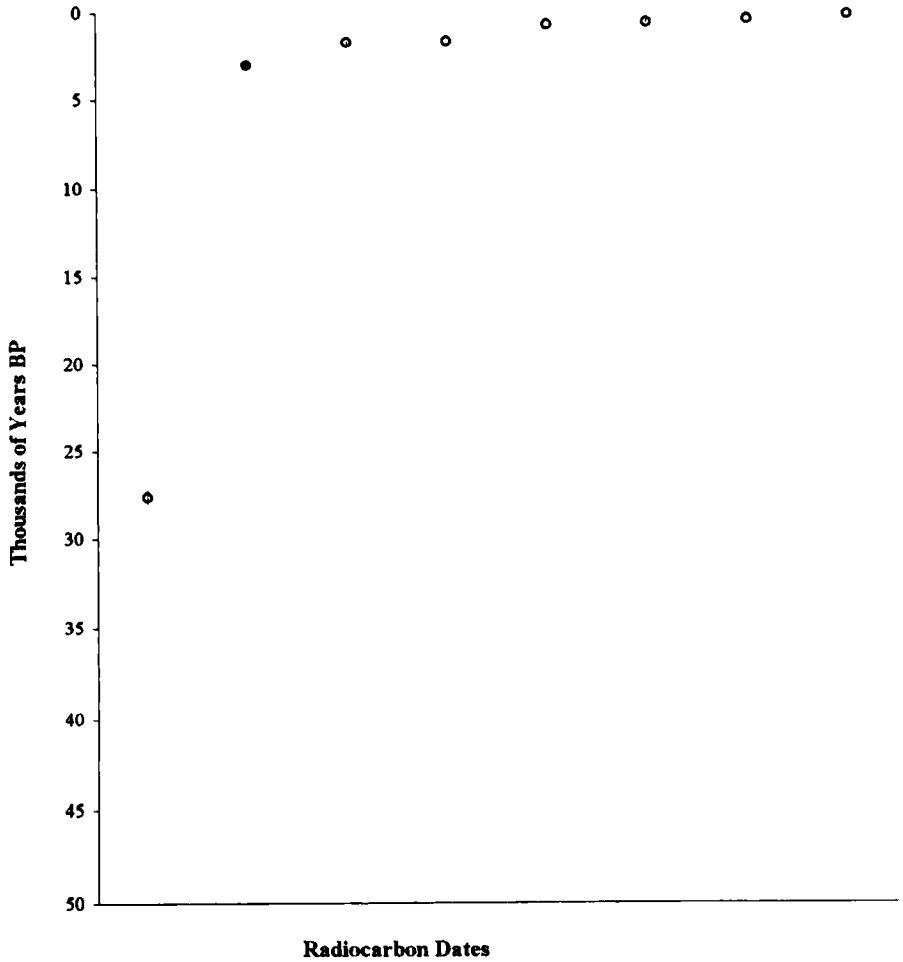

Fig 4 24 Mid-Midlandian to Littletonian radiocarbon record for Irish horses showing new and previous dates. (± error bars shown with open circle– previous date; closed circle– new date).

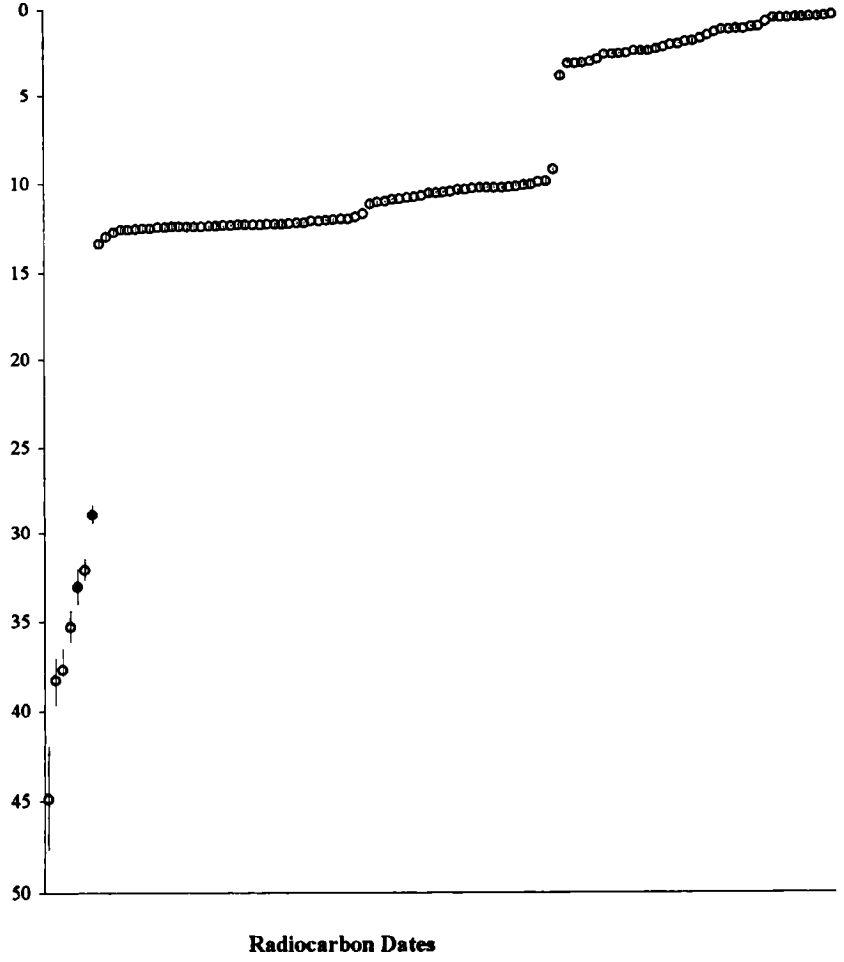

Fig. 4 25. Mid-Devensian to Flandrian radiocarbon record for British horses showing new and previous dates. (± error bars shown with: open circle previous date, closed circle– new date). Note: new previous dates from c. 15,000-0 BP not delimited.

(together with the lack of direct dates), the present author is forced to treat the Newgrange animals simply as small horses possibly from the Beaker period. Because of time constraints, it was not possible to date these horses as part of the current project. Therefore, it is probable that morphological comparisons with British mid-Holocene horses will provide some much-needed alternative information regarding these Irish horses (see chapter 5)

4.5.3 Review of the dating evidence for horse: continental Europe

Previous and new evidence

Ninety-three reliable (i.e. excluding mixed species bulked determinations or burnt/charred material) direct radiocarbon dates for horses from 40 different continental European Late Pleistocene (Mid-Weichselian) to Holocene sites are available (Appendix 1). The dated material consists of bone and tooth; however, in one case, horse dung yielded a date (i.e. VRI-113). As with the British/Irish evidence, that from continental Europe incorporates a mixture of direct dates, bulked dates and associated dates (from selected Late Glacial/early Post Glacial sites only). Below is a brief review of existing and other dating evidence relating to horse material from three key periods: Middle to Late Weichselian, Late Glacial/early Post Glacial, and middle Holocene and later.

The Mid-Late Weichselian radiocarbon record (i.e. pre-Late Glacial and excluding specifically Late Glacial dates) (Appendix 1 and figs. 4 26, 4.27) shows horse to have had an almost continuous distribution from c. 30,000-16,400 BP with gaps at c. 25,000 BP and c.19,000-18,000 BP. Significantly, the latter gap coincides with the 'Last Glacial Maximum' which occurred during the period c. 22,000-18,000 BP (Lowe and Walker, 1997). The majority of these reliable dates (i e 19 of 20 in total) are derived from three continental European sites, in particular: Solutré, France [nine dates]; Kostenki, Russia [four dates]; Brinzeni Cave, Moldavia [six dates].

Interestingly, another gap (c. 16,400-15,200 BP) is evident just prior to the onset of the Late Glacial/early Post Glacial event at c. 15,000-13,000 BP. However, from this time range onward, throughout the pre-Bølling (or "Oldest Dryas"), Late Glacial Interstadial, Younger Dryas Stadial, and early Flandrian, the record shows a fairly continuous distribution for European horses (fig. 4 28). The majority of dates (41 of 49) are concentrated during the Pre-Bølling and Bølling intervals, and of these 41

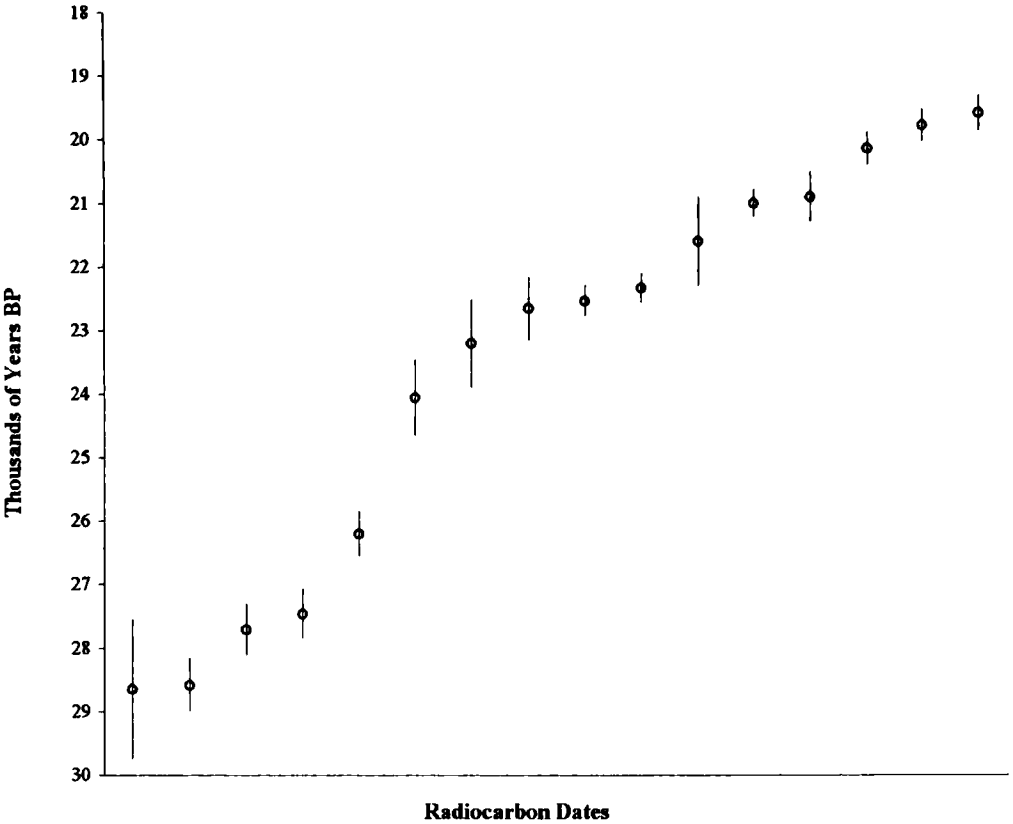

Fig. 4.26. Mid-Late Weichselian (excluding Late Glacial) radiocarbon record for European (excluding British) horses. (± error bars shown with: open circle= previous date).

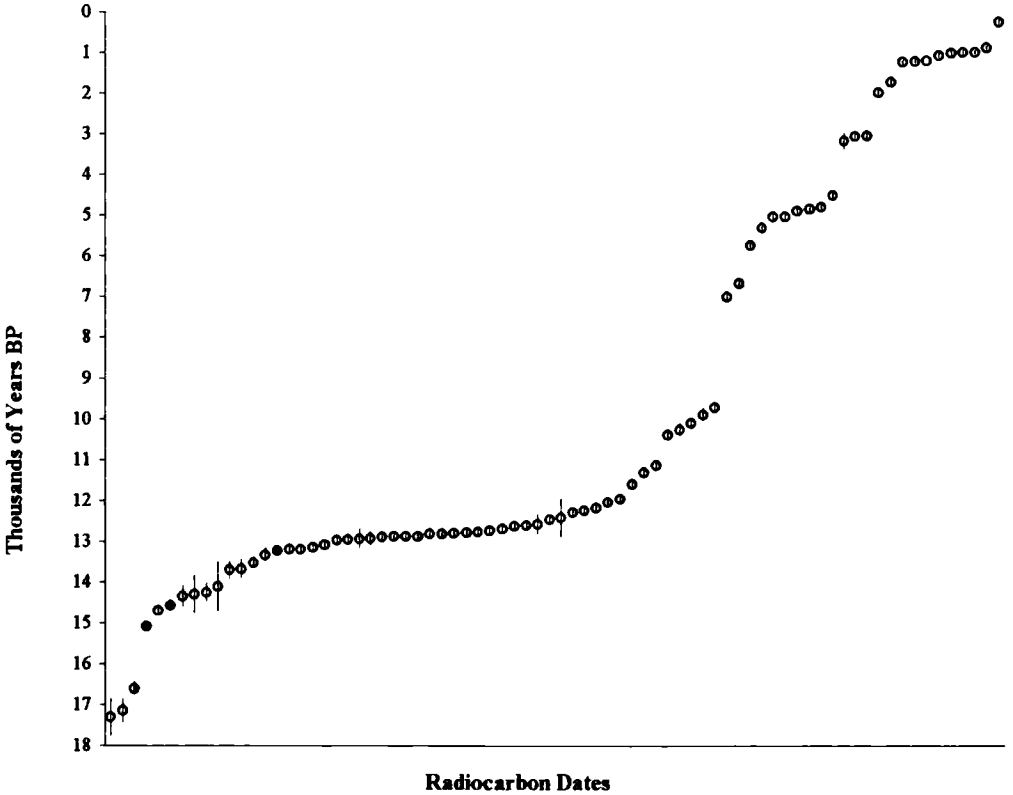

Fig 4 27. Late Weichselian/Holocene radiocarbon record for European (excluding British) horses. (± error bars shown with. open circle– previous date, closed circle– new date).

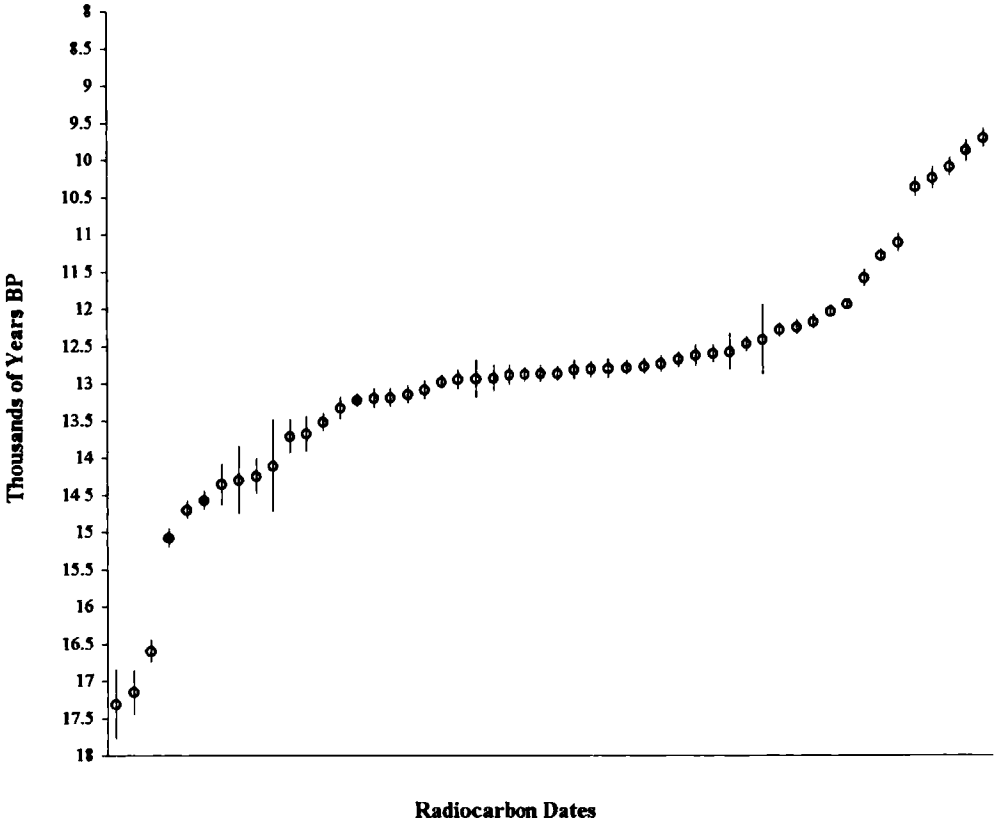

Fig 4 28 Late Glacial/early Post Glacial radiocarbon record for European (excluding British) horses. (± error bars shown with: open circle previous date; closed circle– new date).

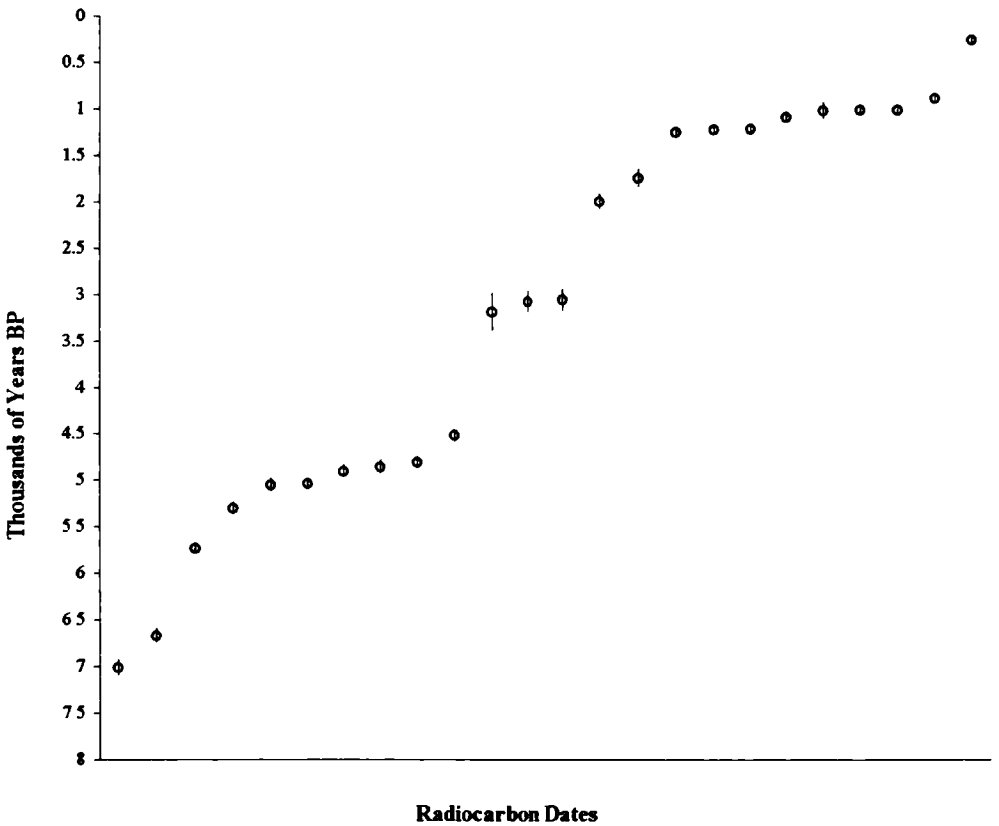

Fig. 4 29 Post Glacial radiocarbon record for European (excluding British) horses showing reliable dates only (± error bars shown with open circle– previous date).

dates, 36 reliable determinations come from continental sites which are located solely in western Europe (e g. Germany, France, Belgium, Switzerland). Furthermore, this group of dates includes the three newly obtained determinations (this project) from Solutré, France [two dates] and Bruniquel, France [one date] (table 4.5), all of which lie within the Pre-Bølling period of the Late Weichselian (i e. c. 15,000-13,000 BP). Also, it is interesting that the three sites mentioned above (i.e. Solutré, Brinzeni, and Kostenki) have yielded additional dates (i e. those in addition to the Mid-Weichselian dates: see Appendix 1), which lie within this pre-Late Glacial Interstadial period. However, in figure 4.28, only eight of the total 49 dates fall within the post-Bølling period (i.e. including the 'Older Dryas' through to the Pre-Boreal), three of which are Allerød dates from three distinct sites, one Swiss (Rheinfelden-Eremitage) and the other two German (Petersfels and Niederbieber). On the other hand, the remaining five are Younger Dryas/Pre-Boreal dates which come from only two sites, one French (Belloy-sur-Somme: 4 dates) and the other German (Kaster). Small, short-lived gaps are evident within the Late Glacial period around the 'Older Dryas'/Allerød transition (c. 11,900-11,700 BP) and the earlier Younger Dryas (c. 11,000-10,500 BP). One large, long-term gap is clear, and it begins during the early Post Glacial at c. 9,600 BP (i.e. the Early Boreal). A discussion of the possible significance of these gaps will be given in section 4.5.4.

After a gap of c. 2,500 years from c. 9,600-7,100 BP, the first appearance of horse in the middle Holocene radiocarbon record of continental Europe occurs at c. 7,000 BP. From this point on, their distributional continuity during the middle to late Holocene is interrupted by several gaps of varying duration (fig. 4.29). Firstly, it is clear that the radiocarbon evidence supports the presence of horses during the middle Holocene of continental Europe from c 7,100-4,500 BP (i.e. Late Mesolithic and Neolithic). Within this interval, however, there is a distinct gap of c. 800 years from c. 6,600-5,800 BP. The record for this middle Holocene period consists of ten dates from four sites (two German, one Danish, and one Spanish). In particular, the German Neolithic site of Bruchsal/Aue (Steppan, 1994), has yielded the majority of horse dates for this period (i e. seven out of the ten) Another significant gap of c. 1,100 years is evident from c 4,500-3,400 BP (i e the Late Neolithic/Beaker earlier Bronze Age), and then only three dates from two sites (one Spanish and one Swiss) cover the period c 3,400-3,000 BP (i.e. the later Bronze Age). There is a further c. 1,000 year gap

during the later Holocene from c. 3,000-2,000 BP, and from then on distribution is fairly continuous through the later Holocene to Recent times.

4.5.4 Dating comparisons: Britain/Ireland versus the Continent

Introduction

Direct comparisons can be made between the British/Irish and continental European radiocarbon records for the Late Pleistocene/Holocene period which incorporates the Mid-Devensian (Mid-Weichselian), Late Glacial/early Post Glacial and the mid-Holocene and later. It is necessary to make these distinctions in order to reveal distributional similarities as well as differences in the wake of environmental and climatic changes which occurred. Also, the morphological comparisons which will be dealt with later in chapter 5 will become more informative as a result of the establishment of a clearer chronology for European horses of the Late Pleistocene/Holocene. For the period in question, c. 40,000-60 BP, the total number of radiocarbon dates (a combination of previous and new reliable dates) available for the two regions is as follows: For Britain/Ireland, there are 116 dates from 64 sites (an average of 1.8 dates/site), and for the Continent, there are 93 dates from 40 sites (an average of 2.3 dates/site) (see Appendix 1).

Overview and Conclusions

Regarding the earliest period (i.e. Mid-Late Devensian/Weichselian or pre-Late Glacial: c. 40,000-15,000 BP), a relatively small number of direct reliable dates are available for the two regions. In Britain and Ireland, only seven dates from seven sites fall within this period; while, in continental Europe, there are 20 dates from four sites. Interestingly, two different scenarios are evident here. For Britain and Ireland, it is clear that not enough material has been dated for this period, resulting in an overall scarcity of dates and a complete lack of multiple dates (i.e. two or more) for sites. However, for the Continent, the number of dates is not as much of a problem as the number of sites represented (i e. only four). Although two areas of the Continent (western: e g France, eastern: e g Moldavia and Russia) are represented by these 20 dates, this cannot be considered as sufficient for dependable comparisons. Given the amount of fossiliferous material available from European pre-Late Glacial sites, the current picture is probably not a true representation of the chronological distribution of

horses during this period. Thus, because the two records are clearly incomplete, it is difficult (and risky) to directly compare radiocarbon evidence from Britain/Ireland (fig. 4.25) and continental Europe (figs. 4.26 and 4.27) for this period.

In contrast to the earlier interval, the largest number of dates for both regions come from the Late Glacial/early Post Glacial period (c. 15,000-9,000 BP). The record for Britain (there are no Irish dates for this period) (fig. 4.14) consists of 63 dates from 27 sites, while the continental record (fig. 4.28) incorporates 49 dates from 27 sites. Although the sites in Britain are wide-ranging, covering a great geographical area (see section 4.6), the continental sites cover a much wider territory. Sites on the Continent with horses dating to the Late Glacial/early Post Glacial range from France and Belgium in the west to Russia and Moldavia in the east. It is interesting, though, that the 49 continental dates come from 27 sites spread over eight countries. On the other hand, the British record is uniquely rich because all 63 dates are derived from 27 sites of the same country. Thus, this chronological evidence can be considered as more definitive than that of the Continent. This is not to say that the continental data are not reliable; and for comparative purposes, they are important because of the direct geographical connection (i.e. via landbridges) to the British Isles during the Late Glacial (see section 4.7 and chapter 3: section 3.3).

The Pre-Bølling gap (i.e. pre-13,000 BP) detected in Britain is not apparent in the continental record. In fact, the chronological distribution of continental horses for the Late Glacial period begins at c. 15,000 BP with a newly obtained date (this project) from Solutré, France during the Pre-Bølling (or "Oldest Dryas"); while, the British distribution begins some 1,500 years later at c. 13,300 BP (i.e. close to the start of the Bølling Interstadial) (figs. 4.14 and 4 28) It may be significant that several dates (at least ten) are available for the Continent from c.15,000-13,300 BP, while only one is available for Britain. This discrepancy may be the result of regional differences in environment and climate during this pre-Late Glacial period. See section 4.7 and chapter 3 (section 3.3) for an in-depth discussion of these issues.

For both Britain and the Continent, there is a continuous presence of horses from c 13,000-12,000 BP (i e. throughout the Bølling Interstadial); however, there are some differences in dispersion of dates throughout this c. 1,000 year period. For example, the continental record shows (fig. 4.28) that the majority of Late Glacial/early Post Glacial dates are dispersed within the Bølling; while in Britain, less than half of the Late Glacial/early Post Glacial dates lie within this interval Furthermore, there are far

more continental dates than British ones which lie within the early-middle Bølling (i.e. c. 13,000-12,500 BP). In fact, the majority of continental dates for this period are concentrated within the earlier part of the Late Glacial/early Post Glacial event, leaving only a handful of dates (i.e. eight) to fill in (only partly) the Allerød Interstadial, Younger Dryas Stadial, and Pre-Boreal periods. Conversely, a number of British dates (i.e. 34) are available for these post-12,000 BP periods, and significantly, many of these dates were obtained as a result of the current project. Furthermore, it must be noted that continental dates are available which partly bridge the later Allerød gap (i.e. from c.11,500-11,200) evident in the British record. However, during the earlier Younger Dryas (i.e. 11,000-10,500 BP), continental dates are lacking in comparison to continued presence in Britain from c. 11,000-10,000 BP (i.e. the entirety of the Younger Dryas Stadial) (fig. 4.14).

As alluded to above, the radiocarbon record in Britain for the Younger Dryas/Pre-Boreal is much richer than that of the Continent. The scant evidence for the Continent of five dates from only two sites, ranging within the period c. 10,500-9,500 BP, is dwarfed in comparison to the 18 dates from 14 sites in Britain for the same period. Although there is a short gap in the British record from c 9,600-9,100 BP, at least one date at c. 9,100 BP extends the Pre-Boreal range into the Early Boreal, whereas no Pre-Boreal or Early Boreal dates are evident post-9,500 BP for the Continent. Instead, there are early Post Glacial sites in Germany and France (e.g. Bedburg-Königshoven and Pont D'Ambon, respectively) which purport to have yielded horse material in deposits of the same age (Street, 1989, 1995b; Uerpmann, 1990); however, it must be noted that none of these sites has, as yet, produced the direct horse dates needed to confirm this. See chapter 5 for morphological comparisons with British material.

Regarding the middle Holocene and later period (c. 9,000-2,000 BP and later), the record for both regions is as follows: 45 dates from 33 sites in Britain/Ireland and 24 dates from 14 sites on the Continent However, it is evident that there are fewer dates available for this lengthy period than for the shorter Late Glacial/early Post Glacial interval, there are even fewer for the key period of c. 9,000-2,000 BP, which incorporates the Mesolithic, Neolithic and Bronze Age. The British/Irish record boasts only 16 dates from 11 sites, while the continental record is even more scant with 14 dates from seven sites. Significantly, the lack of reliable horse dates for this period suggests that horses were not as prevalent during the post-Pleistocene (i e. early and

middle Holocene) of Europe, especially north-west Europe, as they were during the Late Pleistocene era In his review of the transition from wild to domestic horses in western and central Europe, Uerpmann (1990 and pers. comm.) tracks this decline in prevalence from the early Post Glacial through to the Neolithic. Furthermore, Uerpmann (1990) notes that from the Neolithic onward, their frequency at continental sites began to increase; thus indicating, perhaps, the introduction of the domestic horse. However, in Britain/Ireland, the current work has suggested that this increase in prevalence did not become clear until the later Bronze Age (c. 3,000 BP) rather than the Neolithic (figs. 4.19 and 4.29).

Both the British/Irish and continental records reveal a similar phenomenon: an absence of dates from the Pre-Boreal/Early Boreal through to the Mesolithic (or Later Boreal). In Britain/Ireland, a complete absence of dates is evident even beyond this period through the Late Mesolithic/Early Neolithic (or Atlantic) (i.e. from c. 9,000-4,000 BP); whereas, on the Continent, this long gap is bridged by ten middle Holocene dates which range from c. 7,100-4,500 BP (fig 4.29). Four continental sites in western Europe (southern Germany, southern Spain, Denmark) have provided these determinations (Appendix 1). In contrast, the first reliable British/Irish date for the middle Holocene does not occur until c. 3,900 BP (i.e. the later Neolithic); and then, only one reliable date (i.e. Grimes Graves) is available for the Neolithic period. Interestingly, however, no similar continental dates are available within the interval c. 4,500-3,400 BP (i.e. the later Neolithic/Beaker/earlier Bronze Age). From c. 3,200 BP onwards (to c. 60 BP), in both regions, the presence of horses appears to have been fairly continuous, especially in Britain/Ireland. However, it does appear that on the Continent, more gaps are present in the later Holocene to Recent chronological record (fig. 4.29). Clearly, more radiocarbon evidence is available for Britain/Ireland during the period from the Late Bronze Age onward. In fact, the majority of the British/Irish Post Glacial (c. 10,000 BP to Recent times) dates available are concentrated within this period (i e. post-3,000 BP) (figs. 4.19 and 4.25). This may result in part from the dating of supposed middle Holocene horses which yielded unexpectedly young dates, as has been evidenced in the current project (e g Durrington Walls, Fussell's Lodge). It is interesting that a similar dating problem occurs on the Continent For example, Uerpmann (1990) notes that upon dating supposed Neolithic horse material from a German site, Kaster, a Younger Dryas (i e Late Glacial) date was obtained instead. Although this is evidence of encroachment from older deposits, the problem of

intrusions from younger contexts is so widespread that the dangers in assuming 'provenance equals age', must be re-emphasised. With this in mind, it is necessary to stress, again, that the original context of excavated faunal material can never be known with certainty. Although associated or general site dates can be used as a guide, there can never be a substitute for the direct dating of individual specimens.

As in Britain/Ireland, horse material from many middle Holocene continental sites remains undated. Indirect dates are, of course, available (see Appendix 1), but as alluded to above, this is not entirely satisfactory. The current project has made an impact on the British material, but on the Continent, there are many more middle Holocene sites with potentially important remains which are not directly dated. See table 4.4 for a list of sites for which direct dates are lacking. Some sites have material which could potentially fill in some of the gaps in the radiocarbon record (fig. 4.29) or at least add to the existing one. For example, as suggested by their associated or general site dates (Appendix 1), several Late Glacial sites listed in table 4.4 (e.g. Grotte de Remouchamps, Belgium; Miesenheim II and Kartstein Abri, Germany) have yielded horse remains which may date to the intervals for which direct determinations are scarce or lacking (e.g. Allerød and Younger Dryas). Also, direct dating is needed for several key sites (e.g. Henauhof NW, Germany; Roucadour, France; Csepel-Háros, Hungary) which have yielded horse in Mesolithic (c. 9,000-7,000 BP) and later Neolithic/Beaker/Early Bronze Age (c. 5,000-3,500 BP) deposits.

A final important point must be highlighted concerning the difference between the type and quantity of available dates for Britain/Ireland and the Continent. Firstly, it must be reiterated that only reliable dates were utilised in making comparisons between the radiocarbon records of the two regions. For the purposes of this project, the numerous mixed species bulked determinations were not highlighted. The author does not consider these dates to be truly representative of the age of the horse specimens, and like other unreliable dates (i.e. on burnt/charred or low collagen specimens), there is a possibility that the dates may have become contaminated by the older or younger non-horse material or vice versa (e g. see problems with Drayton Cursus horse in section 4.5 2). Thus, as with the associated or general site dates, these bulked determinations must only be used as a rough guide to the age of the horses and not be considered as definitive Not many of the British/Irish dates (i.e. only three) are mixed species bulked determinations, however, several (i e 18) of the continental

dates are (Appendix 1), and thus are considered in this work as too frequent and unsound to be utilised in the compilation of a reliable radiocarbon record.

Furthermore, it is important to mention the significance of multiple dating (i e. obtaining two or more dates) of horse at individual sites. The radiocarbon chronology can be examined more clearly at sites with multiple dates Interestingly, there is a distinct difference between the two regions regarding the amount of multiple dates per site, the Continent having a significantly higher average number of dates per site (i.e. 2.3 as opposed to 1.8 for Britain/Ireland) for the Late Pleistocene/Holocene. Also, for the period c. 40,000 BP to Recent, the Continent has a slightly higher percentage (i.e. 15/40 = 37.5 %) of total sites with multiple dates than does Britain/Ireland (i.e. 20/64 = 31.25 %). Interestingly, the continental dates from these 15 sites (nine of which have three or more dates per site) cover all three key periods, the majority of dates lying within the Late Glacial/early Post Glacial and mid-Holocene and later periods. On the other hand, the British/Irish record boasts no multiple dates for the pre-Late Glacial period (i.e. Mid-Late Devensian), all of them falling within the Late Glacial/early Post Glacial and mid-Holocene and later periods. However, 12 of the 20 sites with multiple dates incorporate three or more dates per site, a similar ratio (3:5) to that of the Continent. There is one very important factor which has brought about this similarity: the results of the present radiocarbon dating project. The new dating of British/Irish material has made such a positive impact, that over half (i.e. 12 sites) of the 20 sites listed with multiple dates have benefited from the new dates produced as a result of the project (i.e. either adding to 'previous' dates or new set of multiple dates).

It is clear that the results obtained from the direct dating of horse material are very important to the chronological distribution question. Recent radiocarbon dating reviews for Britain and Ireland (e.g. this project; Woodman *et al.*, 1997) as well as the Continent (e.g. Street and Baales, 1997) have contributed much to the Late Pleistocene/Holocene records of their respective regions The aim of the present work has been to compile the available regional data (including the novel data generated by this project), and to make comparisons in ways which have not previously been attempted. Problems and pitfalls have been highlighted along the way, and serve as a guide to potential dating projects of the future. As it stands, the records for both Britain and the Continent (see figs 4.22 and 4 27) clearly show that horses were prevalent throughout much of the Late Glacial (c. 13,000-10,000 BP), a fact which was not known, until now, with much certainty (e g. Housley, 1991; Woodman *et al.*, 1997).

However, there are significant regional differences with respect to their pre-Late Glacial and Post Glacial records as well as certain short-lived episodes (e.g. the later Allerød oscillation) of the Late Glacial/early Post Glacial record. The following sections (sections 4.6, 4.7) attempt to deal in-depth with the underlying factors (e g. geography, climate, environment) associated with these chronological differences.

4.6 Discussion of the geographical and chronological distribution of horses in Britain

4.6.1 Introduction

The aim of this section is to look at horse distribution in relation to chronology from a purely geographical aspect. For the purposes of this project, only the Late Glacial and Post Glacial periods are encompassed in this review because their evidence is much more comprehensive than that from the earlier periods (e.g. Middle Devensian). It must be noted that this is the first geographical study of its kind to be attempted regarding Late Pleistocene and Holocene British horses, although similar studies have been done for other taxa in Britain and continental Europe (e.g. Stuart, 1977, 1991). Distribution was determined by identifying the British sites with horse remains (mainly radiocarbon dated specimens), grouping them by county (i.e. within the regions designated in table 4.1), and displaying them on maps for the different periods concerned (see below for how maps are to be interpreted). Sites with undated horse are included on the maps if there is a strong indication that their horse remains date to the relevant interval (i e firm evidence that they originate from dated deposits) (see gazetteer: section 4 3.2). Although, as indicated above, caution must be attached to these assumptions. For convenience, the distributional continuity identified within Late Glacial/early Post Glacial and within the middle and later Post Glacial will be dealt with separately below. This will enable distributional transitions (e g. between periods and/or sites) to show up more vividly.

4.6 2 Geographical distribution

Ten maps (figs. 4.30-4.39) are presented in the discussion below. Each is a schematic diagram of mainland Britain with the counties delimited. Counties that contain relevant sites with horse are highlighted to indicate conceivable distributions of

populations. However, a few important points must be made with regard to this jump from data to interpretation.

1) The distributions (e g. by area) shown on each map may be biased by sample availability. For example, only well-known sites with reliably dated horse can be depicted on the maps as a result of the extent of data available. Thus, if and when more data becomes available, these distributions are subject to change.

2) A jump from data to interpretation is only valid if caution is attached to those deductions. Firstly, the data must be taken at face value, and only subsequently, in relation to the available corollary information (e.g. physical geography), can the original data be made to fit to a scheme such as the distributional maps presented in this section.

3) The regional distributions suggested below are supported by the potential for the existence of 'ghost ranges'. These are defined as the ranges which would supposedly link populations distributed within the highlighted (and closely situated) counties on the maps. However, these 'ghost ranges' must take account of the physical geographical barriers (e.g. mountain ranges, rivers) that could have restricted population distribution. See below for examples.

Distribution during the Late Glacial early Post Glacial

Figure 4.30 shows the geographical distribution of horses throughout the Late Glacial/early Post Glacial. It is evident from this figure that wild horse populations of this period covered an enormous geographical area in Britain alone. Radiocarbon dated horses are available from cave sites as far north as southern Scotland (e.g. Green Craig) and as far south as south-western England (e g. Three Holes Cave, Kent's Cavern). As alluded to above, horse in the Pre-Bølling period is represented only by finds from one site in west-central England, King Arthur's Cave (fig. 4.31). However, if 'ghost ranges' are taken into account, the distribution of populations probably was extended significantly beyond the boundaries of what is now Hereford and Worcester (i e the county in which King Arthur's Cave is situated). Also, it must be noted that the movement and extent of these populations was probably restricted by the existence of physical barriers such as the Black Mountains to the west and the Severn River and the Cotswolds to the east.

The chronological continuity seen through the Bølling Interstadial (c. 13,000-12,000 BP: early Windermere Interstadial) is evidenced at sites between them

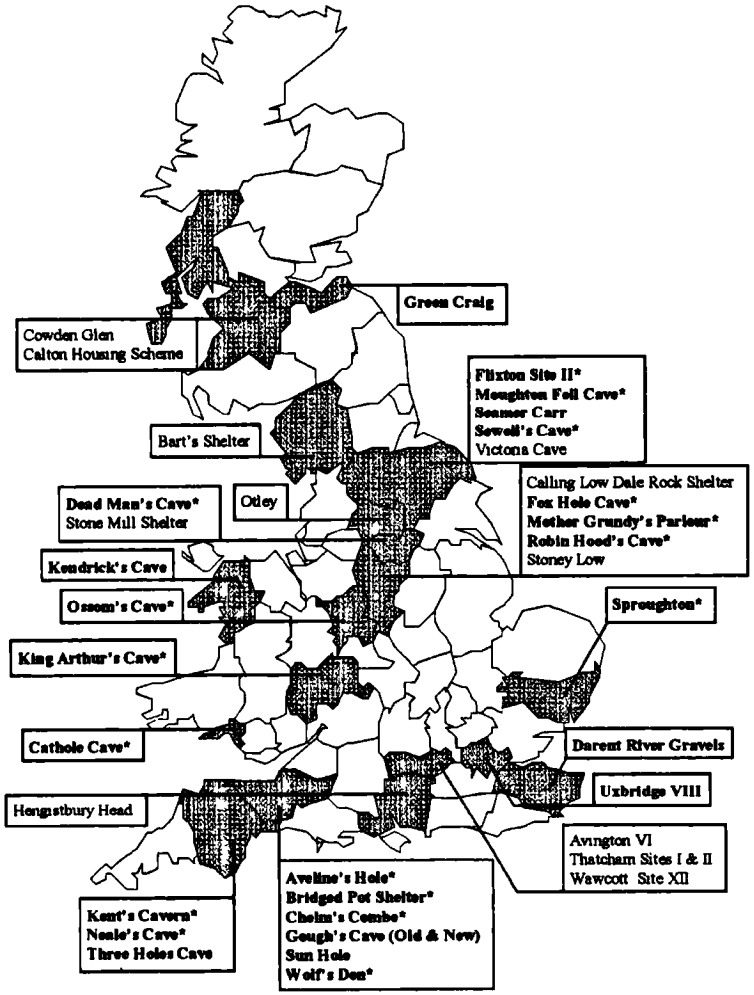

Fig. 4.30. Map of horse distribution in Britain for the Late Glacial/early Post Glacial. (text in BOLD= sites with horse material radiocarbon dated to this period; *= sites which include horse material newly dated to this period; counties are shaded).

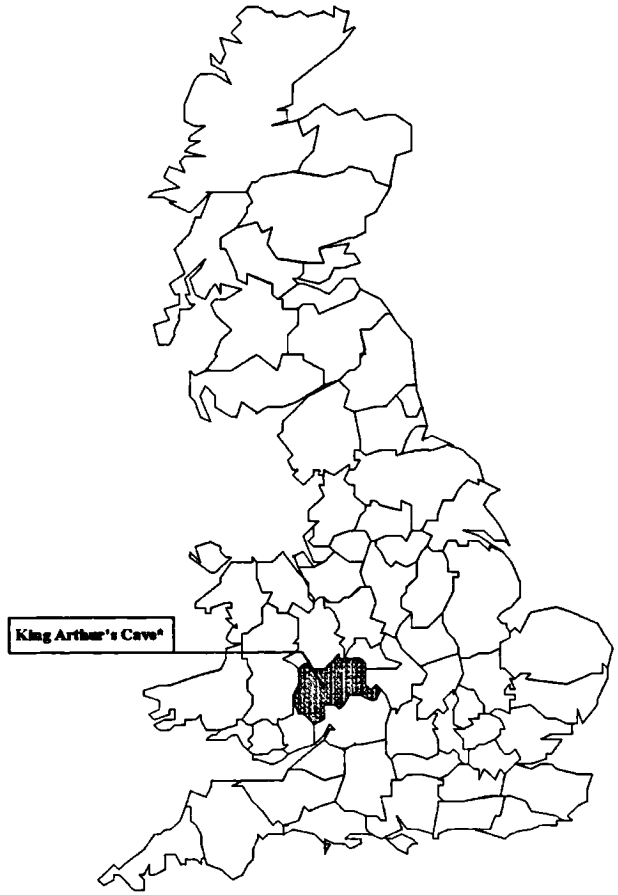

Fig. 4.31. Map of horse distribution in Britain for the Pre-Bølling or "Oldest Dryas": >c. 13,000 BP. (text in BOLD= sites with horse material radiocarbon dated to this period; *= sites which include horse material newly dated to this period; counties are shaded).

spanning this interval from northern (Derbyshire) to southern (Somerset and Devon) England, all of which have radiocarbon dated horse remains (fig. 4.32). Distribution of dated remains during this period does not seem to be biased to either north or south of England. Furthermore, if 'ghost ranges' through the West Midlands and Staffordshire are again considered, the extent of the northern distribution shown in figure 4.32 can potentially be extended southwards to connect Derbyshire with Hereford and Worcester.

During the 'Older Dryas' Stadial/Allerød Interstadial (c. 12,000-11,000 BP: later Windermere Interstadial), however, distribution of sites seems to be biased towards the northern region (e.g. North Yorkshire, Derbyshire) (fig. 4.33). Interestingly, it must be noted that most of the new dates (mentioned above in section 4.5.2) which partially fill in the original 'Older Dryas'/Allerød gap (i.e. from 12,000-11,000 BP) come from British sites which are also more northerly situated (e.g. Mother Grundy's Parlour, Fox Hole Cave, Ossom's Cave, Dead Man's Cave, Moughton Fell, Sewell's Cave), and only a few sites (e.g. King Arthur's Cave, Three Holes Cave) with new and previous dates are more southerly. Hence, for most of this interval (i.e. before and after the gap in presence from c. 11,500-11,200 BP), distribution was confined to the northern region of England, while horses of two more southerly sites (e.g. King Arthur's Cave and Three Holes Cave) are recorded only during the very early part of this one thousand year period (i.e. c. 12,000-11,800 BP). Even though the total exclusion of horses by the Allerød forests from Britain is shown to be false, the present evidence throws up some interesting scenarios. Because afforestation during this period was probably not as wide-spread as was first thought, it is possible that horses flourished in the more open ground environments which were available (and more preferable) in the north of the country (Huntley and Birks, 1983). Also, an alternative hypothesis is that horses became more adaptable to an encroaching forested environment during the Allerød. Thus, this evidence suggests that geographical distribution is related to the climatic oscillations and environmental changes which were occurring at the time. For a more thorough discussion of these variations and their suggested effects on distribution see chapter 3 (section 3 3) and section 4 7 (below), respectively

The chronological continuity which was evident throughout the entirety of the Younger Dryas Stadial (c. 11,000-10,000 BP: Loch Lomond Stadial) is again apparent

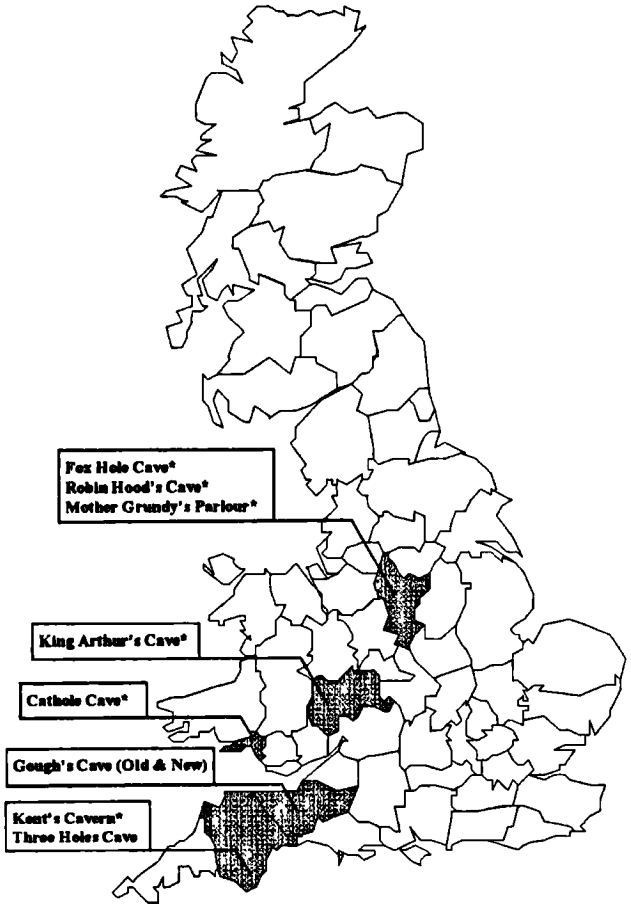

Fig. 4.32. Map of horse distribution in Britain for the Bølling Interstadial (early Windermere): c. 13,000-12,000 BP. (text in **BOLD**= sites with horse material radiocarbon dated to this period; * sites which include horse material newly dated to this period; counties are shaded).

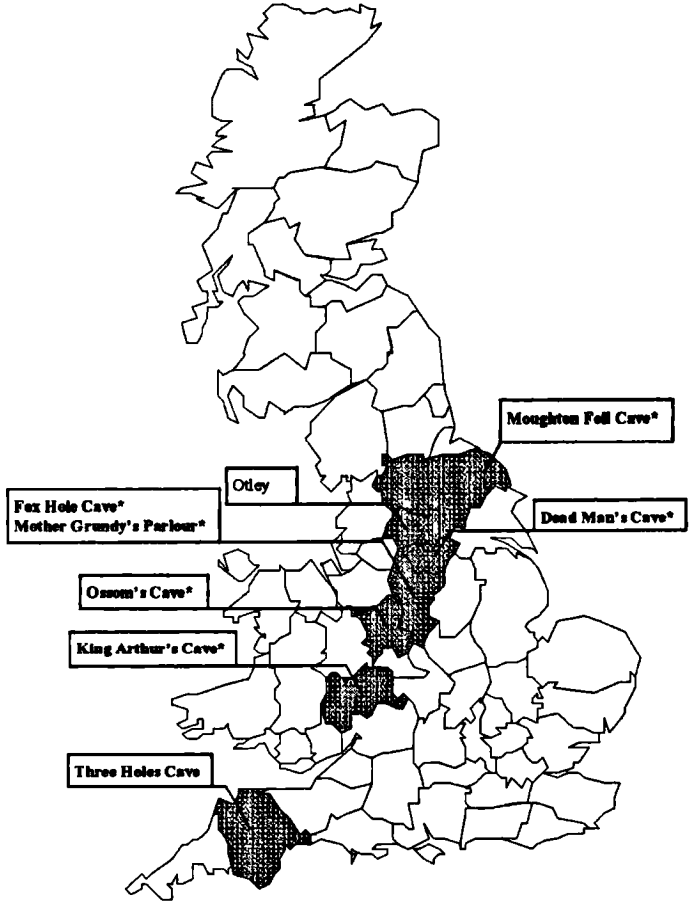

Fig. 4.33. Map of horse distribution in Britain for the Older Dryas Stadial/Allerød Interstadial (later Windermere): c. 12,000-11,000 BP. (text in **BOLD**= sites with horse material radiocarbon dated to this period; * sites which include horse material newly dated to this period; counties are shaded).

geographically Figure 4.34 shows that horses were distributed during this interval from northern (Lothian and North Yorkshire) to southern (Somerset and Devon) Britain and from western (Gwynedd) to eastern (Suffolk) Britain. Sites in central (Derbyshire and Staffordshire) Britain are also represented. Furthermore, it is conceivable that 'ghost ranges' existed in south-eastern (i.e. areas between Greater London and Suffolk) as well as northern (i e. areas between Derbyshire and North Yorkshire) regions. Also, it seems that there are as many sites with dated horse concentrated in the southern region as there are in the northern region of England. In fact, there are several occasions where northern populations seem to be contemporaneous with southern populations (e g. Sewell's Cave and Chelm's Combe at c. 10,700 BP; and Green Craig and Aveline's Hole at c. 10,200 BP: see Appendix 1). These regional examples probably have implications regarding the prevailing climate and environments (each probably favourable to the horse populations) throughout the interval (see section 4.7 and chapter 3: section 3.3).

Distribution during the early Post Glacial (Pre-Boreal/Early Boreal: c. 10,000-9,000 BP) is confined mainly to the northern (North Yorkshire) and the south-eastern (Greater London and Kent) regions of England (fig. 4.35). As above, during this interval, contemporaneity can be shown between wide-ranging regions. For example, at c. 9,800 BP, horses were distributed in both northern and southern regions (i.e. Seamer Carr and Darent River Gravels, respectively). Interestingly, the last area so far proved (i.e. using radiocarbon evidence) to have been inhabited by wild horses is in the northern region of England (i.e. at Flixton Site II, North Yorkshire: c. 9,200 BP). Thus, this evidence suggests that this area was the last refuge in Britain for the wild horses of the Late Glacial/early Post Glacial.

Distribution during the middle and later Post Glacial

Figure 4.36 shows the overall geographical distribution in Britain from the middle through to the later Post Glacial (c. 5,000 BP onwards). However, because this is such an extensive interval which includes the phenomenon of the probable introduction of domestic horses as well as a change in land use practices (see section 4 7 and chapter 3: section 3.3), it is necessary to look at geographical distribution within smaller time intervals, the earlier (c 5,000-2,000 BP) of which is the most relevant to the current project. Figure 4.37 shows that distribution from c. 5,000-2,000 BP (as evidenced by dated specimens) was biased towards the southern and eastern

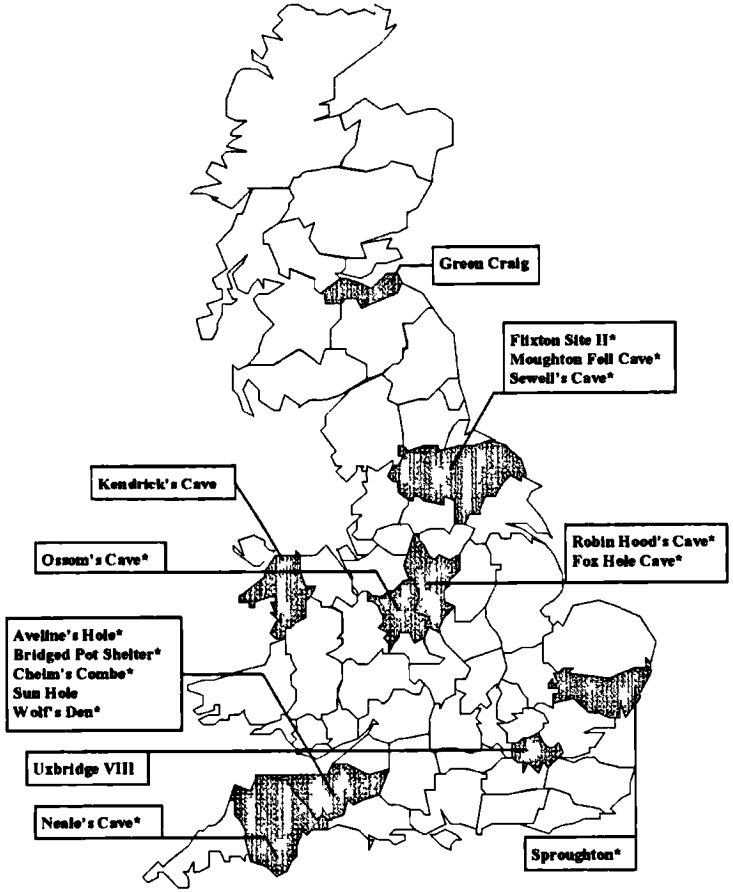

Fig 4 34 Map of horse distribution in Britain for the Younger Dryas Stadial (Loch Lomond). c. 11,000-10,000 BP. (text in **BOLD** sites with horse material radiocarbon dated to this period * sites which include horse material newly dated to this period, counties are shaded)

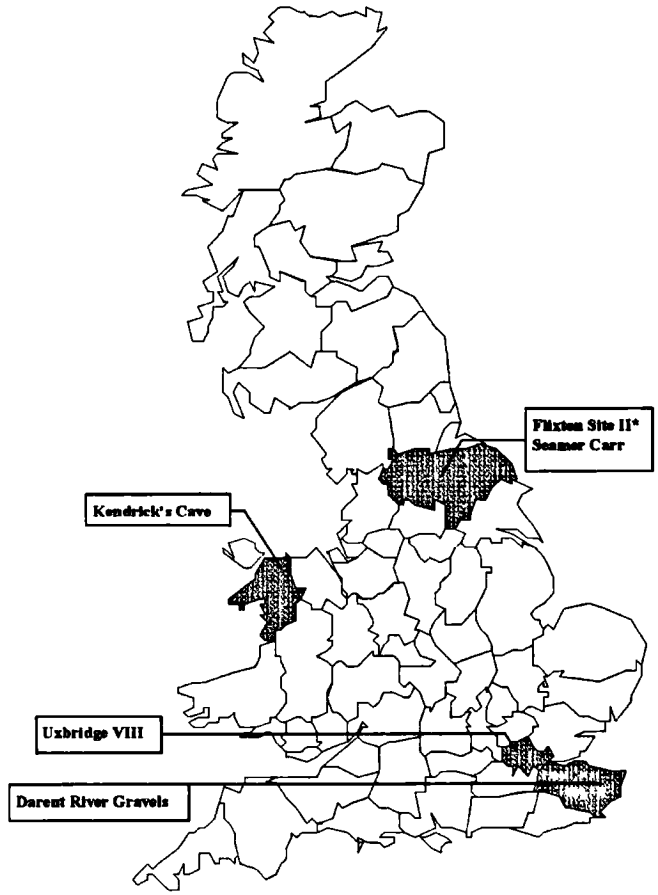

Fig. 4.35. Map of horse distribution in Britain for the Pre-Boreal/Early Boreal: c. 10,000-9,000 BP. (text in **BOLD**= sites with horse material radiocarbon dated to this period; * sites which include horse material newly dated to this period; counties are shaded).

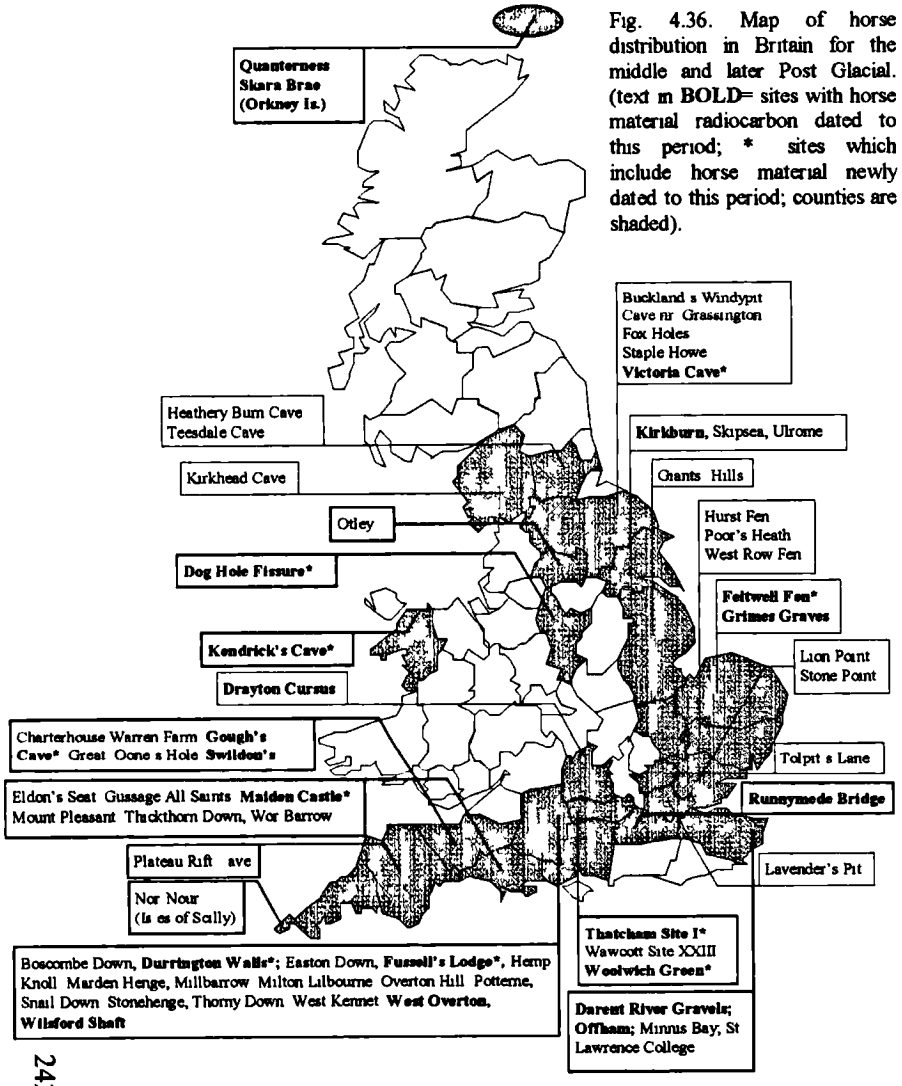

Fig. 4.36. Map of horse distribution in Britain for the middle and later Post Glacial. (text in **BOLD**= sites with horse material radiocarbon dated to this period; * sites which include horse material newly dated to this period; counties are shaded).

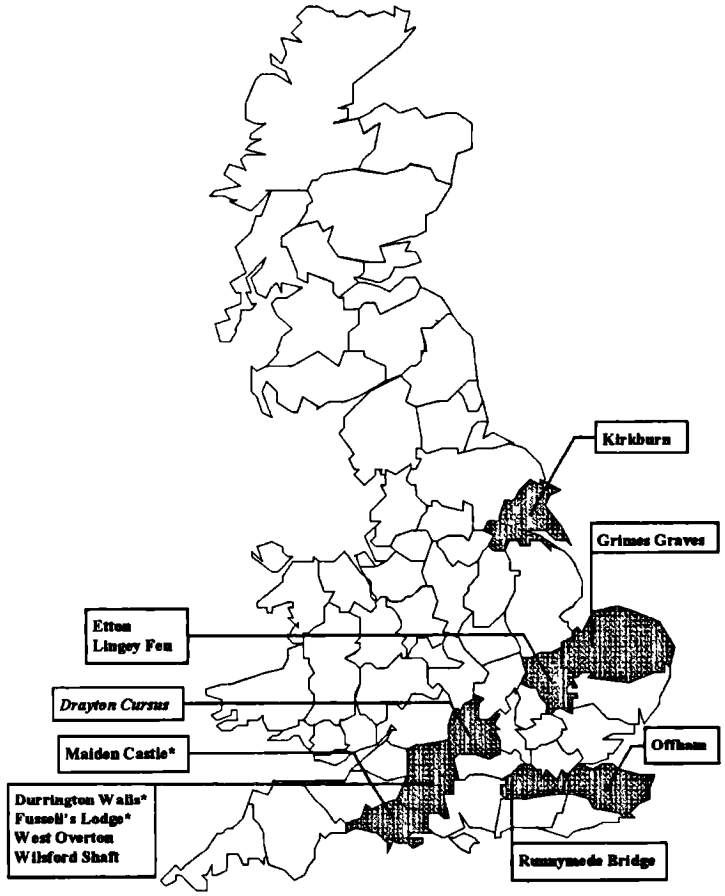

Fig. 4.37. Map of horse distribution in Britain for the Sub-Boreal/Sub-Atlantic (Late Neolithic/Beaker Bronze Age/Iron Age): c. 5,000-2,000 BP (text in **BOLD**= sites with horse material radiocarbon dated to this period; * sites which include horse material newly dated to this period; text in *Italics*= sites include unreliable horse dates; counties are shaded).

regions of Britain (e.g. Wiltshire and Norfolk, respectively). More specifically, figure 4.38 shows a distribution confined to the southern and eastern regions during the key periods of the Sub-Boreal (i e Late Neolithic, Beaker, Early Bronze Age). In addition to the key radiocarbon evidence (e g. at Grimes Graves), the abundance of horse finds originating from sites (and deposits) dating to these periods suggest that horse (possibly domestic) re-appeared in Britain at this time. However, again, it is necessary to stress that because much of the material remains undated, it is not entirely clear whether the horses from every site listed in figure 4.38 date to the Late Neolithic/Beaker/Early Bronze Age. Interestingly, none of the material dated in this project from sites in these regions (e.g. Durrington Walls and Fussell's Lodge, Wiltshire) is depicted on figure 4.38. The reason for this is that the majority of dates fall later (i.e. later Bronze Age: see Appendix 1) than the key Late Neolithic to Early Bronze Age interval (see fig. 4.39).

Geographical distribution (based on dated remains only) during the later period (later Sub-Boreal/Sub-Atlantic/Recent: post- c. 3,000 BP) seems to cover a wider range of regions in Britain, from the north (Orkney) to the south (Somerset and Dorset) and the west (Gwynedd) to the east (Norfolk) (fig. 4.39). It must be noted that the majority of sites listed on figure 4.39 yielded new dates (current project) for this later period, and thus allow a more extensive distributional picture than would have been possible prior to this project, with only five of the regions depicted (Orkney [12], Humberside [3], Kent [10], Oxfordshire [6], Somerset [9]: see table 4.1). For example, the new dating has extended geographical distribution to regions [7], [5], and [14]; while enhancing the distribution within regions [3] and [9] (see fig. 4.39). Due to the fact that the majority of new dates obtained were unexpectedly late, the generation of an extended regional distribution during this period was unintentional. Originally, the dating was performed to test whether horse remains from these sites were either Late Glacial/early Post Glacial (e.g Victoria Cave, Kendrick's Cave) or middle Post Glacial (e g. Swaffham Fen, Woolwich Green) in age (see section 4 5.2).

Overview and Conclusions

Although the above evidence suggests that regional geographical distribution in Britain (based mainly on the availability of accurate horse radiocarbon dates) varied during the intervals of the Late Glacial through the Post Glacial, it must be reiterated that uncertainty exists regarding the jump from data to deductions. The existing data

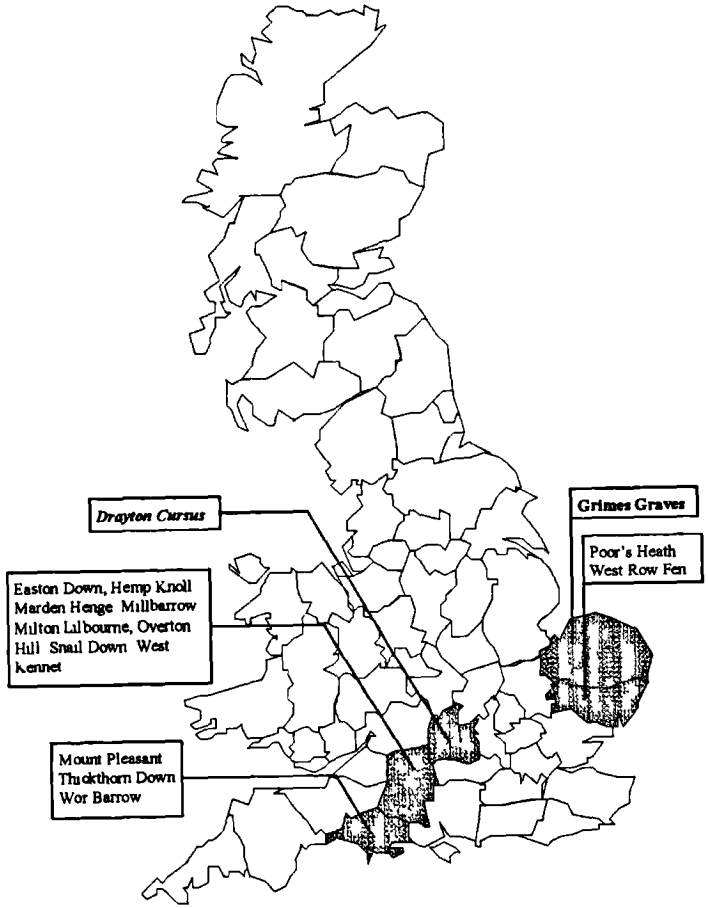

Fig. 4.38. Map of horse distribution in Britain for the early and middle Sub-Boreal (Late Neolithic/Beaker/Early Bronze Age). (text in **BOLD**= sites with horse material radiocarbon dated to this period, * sites which include horse material newly dated to this period; text in *Italics*– sites include unreliable horse dates; counties are shaded)

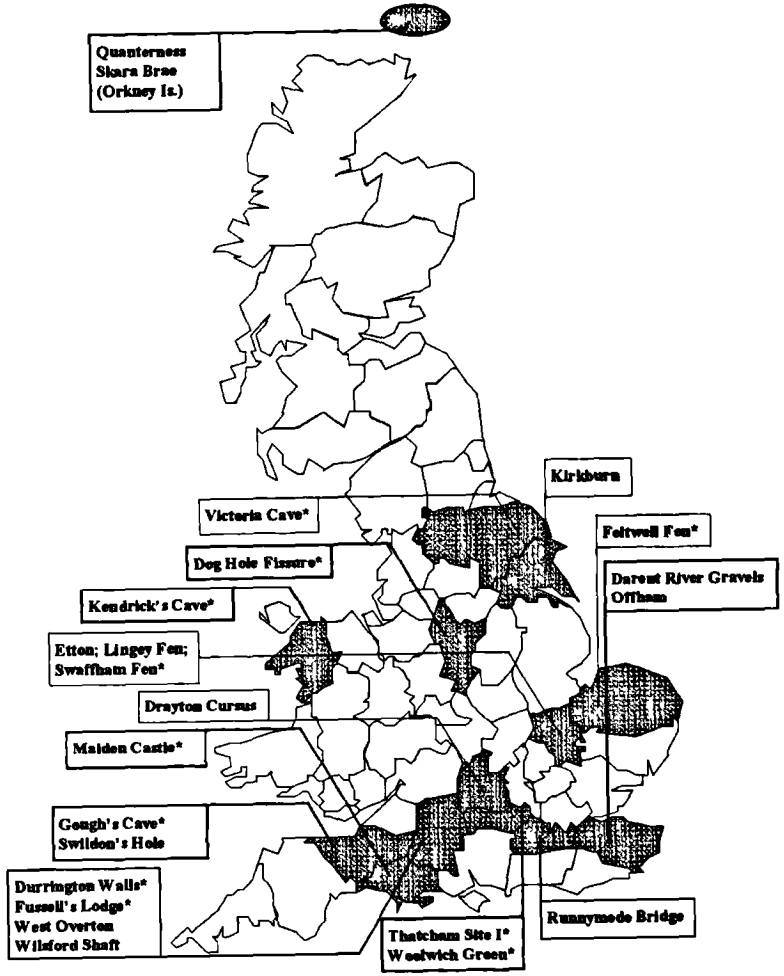

Fig. 4.39. Map of horse distribution in Britain for the later Sub-Boreal/Sub-Atlantic Recent: post- c. 3,000 BP. (text in **BOLD**= sites with horse material radiocarbon dated to this period; * sites which include horse material newly dated to this period; counties are shaded).

(e.g. radiocarbon dated specimens) must be taken at face value until new evidence becomes available to either corroborate or refute the above interpretations. It is also necessary to mention that while the previous section (section 4.5) deals with the chronological evidence and the subsequent section (section 4.7) deals with the environmental/ecological factors which are suggested to have affected geographical distribution, there are other factors which may also have been influential. These factors concern Britain's geographical proximity to other landmasses (the Continent and Ireland) as well as human activities during these intervals.

Firstly, it is important to remember that Britain was not yet an island (in geographical terms) for most of the Late Glacial/early Post Glacial. It was not until the Atlantic (c. 7,500-5000 BP) that Britain is known to have became completely isolated from the Continent (Megaw and Simpson, 1984; Cunliffe, 1993). The persistent connection with the Continent during the Late Glacial/early Post Glacial has implications regarding distribution of mammals within Britain. Certainly, during periods of lowest sea levels (especially during stadials), there was the potential for repeated immigrations and emigrations between landmasses. So, it is necessary to take note of the possibility that some continental populations of horse were morphologically and genetically linked with those of Britain during this period. Similarly, but for different reasons, the populations of the Post Glacial were probably linked. Although the Post Glacial animals could not move freely between areas because of the insurmountable barriers of the North Sea and English Channel, they were probably 'forcibly' imported into Britain from the Continent by the Neolithic/Beaker peoples. Again, the status of the Post Glacial horses of Britain and Ireland will be debated in chapter 6.

The importance of the human influence on horse distribution is evident throughout the Late Glacial and Post Glacial Because the majority of sites with dated horse can be considered to have been a result of human accumulations (e.g. habitation or hunting sites), regional distribution may be biased. For example, during the Post Glacial, there seems to have been a regional bias toward southern England (i.e. in Dorset and Wiltshire) (see fig 4 36) which can be substantiated by the documentation of intense human activity for this region (i e Wessex) (Cunliffe, 1993). In addition, the paucity of dated material from naturally accumulated assemblages supports this supposition even further. However, it must be noted that the present author did make a conscious attempt in this study not only to date, but to include existing dated material

from a variety of sites without human associations in wide-ranging areas (e g. Wolf's Den, Somerset; Moughton Fell Cave, North Yorkshire; Woolwich Green, Berkshire: see figs. 4.30, 4.34 and 4.36) This highlights the necessity for further dating of non-humanly accumulated assemblages in order to reflect the natural distribution of horses during the Late Glacial/early Post Glacial, in particular.

4.7 Discussion of biogeographical and environmental factors in relation to geographical and chronological distribution

4.7 1 Introduction

The aim of this section is to relate the horse radiocarbon record for Britain and continental Europe, with special reference to the climatic and environmental (e.g. vegetation) changes which are known to have taken place throughout the Late Glacial to Flandrian interval. The environmental and climatic reconstructions given in chapter 3 (section 3.3) are related below to the chronological (including continuous and discontinuous) and geographical distributions described above in sections 4.5 and 4.6.

4.7.2 Climate and environment during periods of continuity and discontinuity: Britain

Periods of continuity

Because the animals of the Late Glacial/early Post Glacial were wild (i.e. not under human control), climatic and vegetational factors were probably more influential with regard to horse distribution during this period as compared with those of the later Post Glacial (i.e. Late Neolithic/Beaker onwards) (see below). This highlights the degree of climatic and environmental suitability which was necessary for wild horse survival during the periods of chronological continuity throughout the Late Glacial and early Post Glacial. Chronological continuity of horses began (c. 13,500-13,000 BP) near the opening of the Windermere Interstadial, a period in which the climate was ameliorating from the cold stadial conditions of the pre-Bølling (Lowe and Walker, 1997). The rapid climatic amelioration at this time (chapter 3: fig. 3.1) probably suited the horses which were living in the widely available open habitats which supported vegetation such as Gramineae and herbaceous plants The woodland that developed during the Bølling (see chapter 3: table 3.4) did not seem to affect chronological continuity; however, there is some evidence for geographical variation in horse

distribution during this interval. For example, it seems that the sufficient stocks of grasses needed to support horse populations in an open woodland environment were probably only available in particular areas (see fig. 4.32). This is supported by Lowe and Walker's (1984) evidence for regional differentiation in vegetation patterns during the Late Glacial. Also, it may be significant that after c. 12,500 BP (i.e. the start of climatic deterioration: see chapter 3: fig. 3.1) horse presence was continuous, becoming prevalent during this interval through to c. 11,500 BP. New dating (this project) has helped to prove that horses were present during this transitional period from the later Bølling through a possible 'Older Dryas' event into the early Allerød. However, it seems that the bulk of evidence for horse in the early Allerød (c. 12,000-11,500 BP) is confined to the north of the country (see section 4.5.2 and fig. 4.33) where afforestation is not thought to have been as extensive (i.e. more sporadic) compared to the south (Huntley and Birks, 1983).

The environment and climate from c.11,200-10,000 BP must have been favourable to British horses because of their continuous chronological presence throughout the country (fig. 4.14). The opening up of previously wooded environments would have suited horses because of the subsequent influx of Gramineae, Cyperaceae and herbaceous taxa which are known to have developed in the new tundra/low alpine scrub environments (Walker *et al.*, 1994; Lowe and Walker, 1997). The climate (glacial maximum at c. 10,800 BP) must have been harsh, especially in more northerly regions, but the prevalence of horses during the height of the Younger Dryas (c. 11,000-10,500 BP) seems to support the suggestion that these horses were well-adapted (i.e. morphologically, physiologically, and behaviourally) to cope with extreme climatic conditions (see chapter 1 for modern examples). Also, the arid climatic and environmental conditions which developed during the later Younger Dryas (c 10,500-10,000 BP) would have suited wild horses because of the proliferation of the steppe and halophytic flora (e.g. Gramineae, *Artemisia*) which they are thought to have preferred (based on the known preferences of extant wild and free-living horses: Boyd and Houpt, 1994, and see chapter 1). Furthermore, the mammalian fauna (e g. reindeer, lemmings, steppe pika see chapter 3: section 3.4) repeatedly found in association with Younger Dryas horses at various sites (e g. Aveline's Hole, Chelm's Combe, Ossom's Cave, Sun Hole, Bridged Pot: see gazetteer in section 4.3 2) suggests a steppe/tundra environment which must have supported ample vegetation consisting of grasses and sedges during this period.

The early Post Glacial (c. 10,000-9,000 BP: Pre-Boreal/Early Boreal) environment and climate would have been a challenging one to which wild horses had to adjust. The rapid amelioration of the climate along with the re-development of woodland would have put them under pressure, and probably forced them to either adapt to a more closed environment or migrate to upland areas (or the Continent) in order to survive (e.g. open woodland habitats in the uplands of Somerset described in chapter 3: Cunliffe, 1993). The fact that climatic oscillations were taking place during this period (see chapter 3: fig. 3.1) probably restricted the development and extent of closed habitats, thus allowing areas with open or underdeveloped woodland to persist.

Horse presence from c. 4,000 BP (i.e. the middle Sub-Boreal), a period in which the climate was warmer, drier and more continental, was fairly continuous, especially after c. 3,000 BP (fig. 4.19). By this time, the impact of human agricultural practices on the environment was almost fully established, and the vegetational changes which resulted from forest clearance probably suited the horses which were present post-c. 4,000 BP. Also, an increase in open habitats with abundant herbs, grasses and cereals would have been attractive to any horses, whether they be wild or feral (or free-living) domestic animals. See chapter 6 for a more in-depth discussion of the status of Post Glacial horses.

Periods of discontinuity (i.e. gaps in the chronological record)

A significant gap in the radiocarbon record is evident pre- c. 13,500 BP, and equates with the harsh, arctic environment of the cold Dimlington stadial (or "Oldest Dryas") which preceded the onset of interstadial conditions at c 13,000 BP. Despite the presence of sparse vegetation (i.e. an open habitat flora consisting of low herbaceous plants· Adams and Faure, 1997) beyond the limits of ice cover, it is possible that the climatic conditions may have been too harsh (or at least harsher than conditions experienced in the Younger Dryas, i e. a polar and alpine desert) for the survival of horses as well as other common Late Glacial mammalian taxa. In support of this, non-horse radiocarbon dates from relevant sites are scarce for this period (i e. only two dates from two sites [Pin Hole and Kent's Cavern]: see Appendix 1)

Another interval in which horse appears to have been absent was the later Allerød (c. 11,500-11,200 BP). Although the climate was deteriorating at this time, woodland had already become established in many areas of Britain. Late Glacial pollen diagrams for northern Britain (e g. *fig. 3* in Pennington, 1977; *fig. 3* in Pigott

and Pigott, 1963) depict a sudden decrease in Gramineae, concurrent with an increase in *Betula* and *Juniperus* during this middle to later phase of the Allerød. Thus, the lack of suitable habitats with sufficient stocks of grasses and herbs could have been one of the important factors responsible for the disappearance of horses from the record at this time. It must be noted, however, that the gap detected during the Allerød is in accordance with the available radiocarbon evidence, and could conceivably be as a result of sampling error.

The gap in the record during the Early Boreal (c. 9,600-9,100 BP) may not be as significant in climatic and environmental terms as those described above; however, it must be noted in relation to the changes which took place during this period. The Boreal, a period of distinct climatic amelioration (with climatic oscillations) and transition from open ground/heathland to woodland communities, is significant because it incorporates the last evidence in the early Post Glacial (c. 9,100 BP) for the presence of horse in Britain. It is possible that this gap in the record is evidence in support of greatly declining abundance leading to a complete absence of horse from the Later Boreal through the Atlantic to the early Sub-Boreal. The climatic oscillations which occurred early in the Post Glacial may have allowed certain habitats which were preferred by horses to remain; however, from c. 9,000 BP onward, the climate and environment does not appear to have been the type which could support populations of horses. The warm climatic conditions together with the expansion of woodland throughout Britain would have made it difficult for horse survival. Also, the wetter conditions which characterised the Atlantic period (zone VIIa) would not have been ideal. This does not mean that horses are never able to adapt to a more wooded or wetter environment; for example, extant free-living horses successfully live in or near such environments (e g. free-living horses of the marshy Camargue region, France: see chapter 1). However, these situations are to a degree artificial. Moreover, the one factor which arises repeatedly is the inevitable competition with humans (and eventually their livestock/agriculture) for suitable environments in which to forage and live during the middle Post Glacial. This relationship will be dealt with in more detail in chapter 6 One cannot get away from the fact that the environment during the long period of 5,000 years (c. 9,000-4,000 BP) was not as suitable for free-living horses as it was during the periods of continuity during the Late Glacial.

4.7 3 Climatic and environmental comparisons during periods of continuity and discontinuity: continental Europe versus Britain

The most striking difference in distribution between continental Europe and Britain is evident during the Pre-Bølling period. Chronological continuity in continental Europe begins from c. 15,000 BP and extends through the early Bølling (c. 13,000 BP); whereas, in Britain continuity only begins between c. 13,500-13,000 BP. The reason for this discrepancy could be due to the climatic and environmental differences between the two regions during the pre-Late Glacial interval. Lowe and Walker (1997), for example, note that south-west Europe was the first region to experience a sustained warming event at c. 15,000-14,500 BP, c. 2,000 years before the abrupt warming experienced in Britain. These climatic differences probably had an effect on the extent to which vegetational changes took place in the different regions. Even though geographical isolation had not yet occurred, it is likely that a more suitable habitat (e.g. open steppe) existed on the Continent well before it did in Britain, thus resulting in horse presence at this time (e.g. at sites in south-west France). Alternatively, this difference may be due to a sampling effect in that very few faunally rich sites exist in Britain dating to between c.15,000 BP and c. 13,000 BP in comparison with the Continent. Regarding the differences encountered in the subsequent Late Glacial period, it is interesting that many more continental horse dates seem to be concentrated within the early Bølling (c. 13,000-12,500 BP), rather than the later Bølling (c. 12,500-12,000 BP), as they are in Britain (see figs. 4.14 and 4.28). It is possible that this phenomenon is related to the suggestion of a later onset for the interstadial thermal maximum for areas in continental north-west Europe (e.g. Germany) as well as the persistence of open ground and steppe communities for a more sustained period early in the Late Glacial Interstadial (Lowe and Walker, 1997).

Interestingly, there is no similar significant gap in presence during the later Allerød (c. 11,500-11,000 BP) on the Continent. In fact, the record (fig. 4.28) shows relative chronological continuity from c. 11,700-11,000 BP. The climatic oscillations of this period do not appear to have been as intense as they were in Britain, and this possibly resulted in less environmental variation (Walker *et al.*, 1994) Also, the climatic deterioration that Britain was experiencing at the time was more extreme than on the Continent. Furthermore, an interesting gap in presence on the Continent during the early Younger Dryas (c 11,000-10,500 BP) is in stark contrast with the chronological continuity throughout the entire Younger Dryas in Britain (= Loch

Lomond Stadial). It is clear from pollen studies that there was a difference in vegetation between Britain (tundra and low alpine scrub) and certain areas of continental north-west Europe (e.g. boreal wood and heathland) during this early stadial interval (Walker *et al.*, 1994). In fact, Britain's environmental conditions were probably more favourable to wild horses because of the overall availability of suitable open habitats composed mainly of steppe/tundra vegetation such as grasses (Gramineae), sedges (Cyperaceae) and other herbaceous taxa.

After the chronological continuity of the later Younger Dryas through the Pre-Boreal/Early Boreal, both regions experienced evidence of discontinuity at about the same time (i.e. between c. 9,600-9,000 BP). However, the gap in the continental record only lasted through the Boreal period (Early and Later Boreal: c. 9,600-7,500 BP); and between c. 7,100-4,500 BP (i.e. the Atlantic and early Sub-Boreal), there was relative continuity with a gap of unknown significance at c. 6,600-5,800 BP. Uerpmann (1990) notes that by the end of the middle Neolithic in central Europe, open habitats (e.g. woodland glades, meadows in flood plains) which resulted from human interference would have been available for exploitation by populations of wild horses. For this reason, Uerpmann (1990) suggests that the increase in finds of horse seen in the archaeological record of central Europe during the early to middle Neolithic was as a result of this increase in population density. The very presence of horses on the Continent during this period raises the question of how these horses were able to survive the climatic and environmental shifts. The amount of space available to both humans and animals during these periods was probably a limiting factor regarding distribution The fact that the Continent had more 'space' in terms of geography, in turn implies that there were probably more opportunities for existing populations of wild horses to find suitable habitats. Hence, it is likely that there were more opportunities for interactions between humans and horses. In Britain, however, there were no opportunities for interactions simply because there were no horses. Their absence was probably due to a combination of factors (e g environmental unsuitability and isolation from the Continent), and presence of horses was restored on the British mainland probably as a result of importations from the Continent during the Late Neolithic/Beaker period (c. 4,000 BP). From this point onward, the amount of suitable habitats available was more dependant on human interference (i.e. agricultural impact) rather than natural forces

Chapter Five

The Morphology of Late Glacial and Post Glacial Horses in Britain and North-west Europe

5.1 Introduction

While preceding chapters have alluded to the size of the horses which were present during the Late Pleistocene (especially Late Glacial) and Holocene of Britain and north-west Europe, the present chapter is devoted solely to morphological and anatomical analyses of these remains. The aim in this work is to thoroughly describe the anatomy and morphology of British horses as well as make comparisons with those from continental Europe. A key objective of this work involves the use of cranial and postcranial specimen measurements from particular sites (see section 5.2) to create size comparisons (i.e. biometrical studies using morphometric methods). Firstly, this entails making both intra- and inter-site comparisons within Britain; and secondly, creating some of the same comparisons outside of this region. The final analysis will embrace inter-site comparisons across geographical areas as well as the chronological intervals of Late Pleistocene and Holocene of north-west Europe.

Several key themes regarding the morphology of British Late Glacial and Post Glacial horses will be tackled in the following sections.

Key objectives:

- Provide a morphological study of elements (i.e. bones and teeth: both fossil and modern) using standardised measurements
- Employ statistical and graphical techniques to analyse intra-specific measurement data
- Demonstrate and identify morphological diversity between individuals and/or populations (e.g. 'types' through time and space)
- Supply information about 'true' size and shape (e.g. estimation of body size: withers height and body weight)
- Provide information (e.g. size variation) on the relationships between ancient and modern groups (both wild and domestic animals)
- Establish the idea of bones and teeth as ecologically important variables (see below)

- Highlight, in the present work, that the use of directly radiocarbon-dated specimens (see chapter 4) in morphological comparisons allows for more reliable chronological comparisons
- Examine evolutionary issues such as the validity of ideas related to Bergmann's Rule (e g. mammalian body size is inversely correlated with environmental temperature)
- Identify factors influencing horse morphology (e.g. geographic (clines), environmental (climate, vegetation), anthropogenic (domestication))
- Examine additional variables associated with morphology (e.g. growth, nutrition, age, sex)

In the following sections, it will be necessary first to highlight the key British/Irish and continental European material which is to take precedence in this study. Next, the morphometric methods employed in the study will be highlighted. The accumulated data will then be presented and interpreted using both chronological and geographical criteria. Finally, the available results will be scrutinised in relation to ecological factors (e.g. climate and vegetation) which may have influenced horse morphology during the relevant periods.

5.2 Materials and Methods

5.2.1 Review of available horse material

The availability of relevant material is a very important aspect of this morphological study because it determines the scale and type of interpretation which can be attempted An introduction to the various sites and fossil/sub-fossil material available for study was given in chapter 4; however, not all the material described in the gazetteers will be utilised in the current chapter. This section also includes an introduction to the modern horse material (e.g. Przewalski's horse standard 'population') which will be employed. See tables 5 1-5.6 for a full listing of the ancient and modern material some of which will be used in this biometrical study.

The age of ancient material is crucial in interpretıng morphological comparisons of horses. Therefore, a ranking system has been implemented to discriminate between reliably- and unreliably-aged material Reliably-aged material (rated I) incorporates specimens which have yielded reliable, direct radiocarbon dates in addition to having a well-known stratigraphical provenance, while unreliably-aged material (rated III)

consists of specimens which have neither. On the other hand, because the majority of undated horse material is associated with dated deposits (i.e. via non-horse remains or artefacts with reliable dates), it must not be disregarded, and can be rated midway between the two descriptions above (i.e. rated II). These rankings will be used as a 'reliability guide' with respect to interpretations made later in section 5.3.

Criteria for the selection of material utilised in the morphological analyses include:

- As many and as wide a range of sites (both chronologically and geographically)
- Priority was given to sites in which the majority of anatomical elements are represented and in good numbers
- Sites with 'poor samples' (i.e. a collection in which key anatomical elements are scarce or element numbers are low) were not ignored, because of their potential to supply important and relevant information
- At particular sites, priority was given to description and examination of key anatomical elements (i.e. cheek teeth, metapodials, phalanges, tibiae, radii, astragali) which were usually the best-preserved as well as the most numerous
- Description and examination of additional anatomical elements (e.g. vertebrae, patellae) supplemented the data provided by the key elements

Fossil and sub-fossil horse material from Late Pleistocene and Holocene sites: Britain and Ireland

The author has visited numerous collections throughout England and Wales in order to examine relevant horse material (see chapter 4: table 4.3). Much of the measurement data gathered on these visits is utilised in the current investigation of horse morphology. All 'good samples' were examined from Late Glacial/early Post Glacial and middle Post Glacial sites; however, the data collected from Mid-Devensian and later Post Glacial material come from selected sites only. Small samples were included as there were found to be useful for morphological interpretations, especially where direct chronological information was available (see section 5.3). In addition, measurements published in the literature, are included in this study to supplement the original data. This is especially true for the Irish measurement data which, due to time constraints, could not be collected personally by the author. Tables 5 1-5.3 list the measurable material available from British and Irish sites for three separate chronological periods: 'Period 1' (table 5.1) includes sites of Mid-Late Devensian age

Table 5.1 Measurable Horse Material from British and Irish Sites for Period 1: Mid-Late Devensian (excluding specifically Late Glacial sites)

Site Name	County & [Region No.]	Country	Elements Measured	Source of Data
Brean Down Shelter	Somset [9]	England	Pc	Original
Church Hole Cave	Notts [5]	England	Pc	Original
Clevedon Cave	Somset [9]	England	Pc; CT	Original
Conningbrook Pit	Kent [10]	England	Pc	Original
Coygan Cave	Dyfed [13]	Wales	CT	Original
Elderbush Cave	Staffs [4]	England	Pc; CT	Original
Fisherton	Wilts [9]	England	Pc	Original
Gop Cave	Clwyd [14]	Wales	Pc	Original
Hoyle's Mouth Cave	Dyfed [13]	Wales	CT	Original
Igtham Fissures	Kent [10]	England	Pc	Original
Kent's Cavern	Devon [8]	England	Pc; CT	Original
Langwith Cave	Derbys [5]	England	Pc; CT	Original
Merlin's Cave	H & W [4]	England	Pc	Original
Pryory Farm Cave	Dyfed [13]	Wales	Pc	Original
Shandon Cave	Co. Waterford [18]	Ireland	Pc	Neil (1977)
Torbryan 6	Devon [8]	England	CT	Original
Tornewton Cave	Devon [8]	England	Pc	Original
Whatley Quarry	Somset [9]	England	Pc	Original

Table 5.2. Measurable Horse Material from British Sites for Period 2: Late Glacial/Early Post Glacial

Site Name	County & [Region No.]	Country	Elements Measured	Source of Data
Aveline's Hole	Somset [9]	England	Pc	Original
Bridged Pot Shelter	Somset [9]	England	Pc	Original
Cathole Cave	W Glam [13]	Wales	Pc; CT	Original
Chelm's Combe	Somset [9]	England	Pc; CT	Original
Darent River Gravels	Kent [10]	England	Pc	Original
Dead Man's Cave	S York [3]	England	Pc	Original
Dog Hole Fissure	Derbys [5]	England	?T	Original
Flixton Site II	N York [3]	England	Pc	Original
Fox Hole Cave	Derbys [5]	England	Pc; CT, Cr	Original, Neil (1977)
Gough's (Old&New) Cave	Somset [9]	England	Pc; CT, Cr	Original
Kendrick's Cave	Gwynd [14]	Wales	Pc; CT; Cr	Original
Kent's Cavern	Devon [8]	England	Pc; CT	Original
King Arthur's Cave	H & W [4]	England	Pc; CT	Original
Little Hoyle Cave	Dyfed [13]	Wales	Pc	Original
Mother Grundy's Parlour	Derbys [5]	England	Pc; CT	Original
Moughton Fell Cave	N York [3]	England	Pc	Original
Neale's Cave	Devon [8]	England	Pc	Original
Ossom's Cave	Staffs [4]	England	Pc, ?T	Original
Robin Hood's Cave	Derbys [5]	England	Pc, CT, Cr	Original
Seamer Carr	N York [3]	England	Pc, CT, Cr	Original
Sewell's Cave	N York [3]	England	Pc, CT	Original
Sproughton (Site 1)	Suffk [7]	England	Pc, CT, Cr	Original
Sun Hole	Somset [9]	England	Pc, CT, Cr	Original
Thatcham (Sites I & II)	Berks [9]	England	CT	Original
Thor's Fissure Cave	Staffs [4]	England	Pc	Original
Three Holes Cave	Devon [8]	England	Pc; CT	Original
Uxbridge VIII	Middx [6]	England	CT, Cr	Original
Victoria Cave	N York [3]	England	Pc; CT	Original
Wolf's Den	Somset [9]	England	Pc	Original

Table 5.3 Measurable Horse Material from British and Irish Sites for Period 3: Mid-Late Holocene (Late Mesolithic/Neolithic/Bronze Age & later)

Site Name	County & [Region No.]	Country	Elements Measured	Source of Data
Ballyveelish (F19 & F67)	Co. Kildare [17]	Ireland	Pc	F. McCormick (pers. comm)
Boscombe Down	Wilts [9]	England	Pc	Original
Danebury Hillfort	Hants [9]	England	Pc	Grant (1991)
Durrington Walls	Wilts [9]	England	Pc; CT	Original
Eldon's Seat	Dorset [9]	England	Pc, CT	Original
Feltwell Fen	Norfk [7]	England	Pc	Original
Fengate Sites	Cams [7]	England	Pc	Harmon (1978); Biddick (1980)
Fussell's Lodge	Wilts [9]	England	CT	Original
Great Oone's Hole	Somset [9]	England	Pc	Original
Grimes Graves	Norfk [7]	England	Pc	Legge (1981, 1992)
Gussage All Saints	Dorset [9]	England	Pc	Harcourt (1979)
Heathery Burn Cave	Co. Durham [1]	England	Pc	Original
Hemp Knoll	Wilts [9]	England	Pc; CT	Original
Jarlshof*	Shetland [12]	Scotland	Pc	Neil (1977)
Lavender's Pit	Middx [6]	England	Pc, CT	Original
Lion Point (Jaywick Sands)	Essex [7]	England	CT; Cr	Original
Lough Gur (site C)*	Co. Limerick [18]	Ireland	Pc	Neil (1977)
Loughrea*	Co. Galway [16]	Ireland	Pc	Neil (1977)
Maiden Castle	Dorset [9]	England	Pc; CT; Cr	Original
Marden Henge	Wilts [9]	England	Pc	Original
Millbarrow Chambered Tomb	Wilts [9]	England	Pc	Whittle (1994)
Milton Lilbourne	Wilts [9]	England	Pc; CT	Original
Minnis Bay	Kent [10]	England	Pc	Original
Mount Pleasant	Dorset [9]	England	Pc; CT	Original
Newgrange	Co. Meath [17]	Ireland	Pc	van Wijngaarden-Bakker (1974, 1986)
Overton Hill (The Sanctuary)	Wilts [9]	England	Pc	Original
Plunkett Cave	Co. Sligo [16]	Ireland	Pc	Neil (1977)
Poor's Heath (Flempton)	Suffk [7]	England	Pc; CT	Original
Runnymede Bridge	Surrey [10]	England	Pc	Original; Done (1991)
Skipsea	Humb [3]	England	Pc	Original
Snail Down	Wilts [9]	England	Pc; CT	Original
St. Lawrence College	Kent [10]	England	CT	Original
Staple Howe	N York [3]	England	Pc, CT	Original
Stone Point	Essex [7]	England	Pc; CT	Original
Stonehenge	Wilts [9]	England	Pc, CT	Original
Swaffham Fen	Cams [7]	England	Pc; CT; Cr	Original
Teesdale Cave	Co. Durham [1]	England	Pc; CT	Original
Thorny Down	Wilts [9]	England	CT	Original
Tolpit's Lane	Herts [6]	England	Pc	Original
Ulrome	Humb [3]	England	Pc	Original
West Row Fen	Suffk [7]	England	Pc	Original
Woolwich Green	Berks [9]	England	Pc	Original
Wor Barrow	Dorset [9]	England	Pc	Neil (1977)

For tables 5 1-5 3: * denotes sites not listed in the gazetteers (see chapter 4); entries in **BOLD** radiocarbon dates available for horse, Pc Postcranials, CT Cheek Teeth, Cr Cranials

(excluding specifically Late Glacial sites), 'Period 2' (table 5.2) includes sites of Late Glacial and early Post Glacial age, and 'Period 3' (table 5.3) includes sites of mid-late Post Glacial (Late Mesolithic/Neolithic/Bronze Age and later) age.

Fossil and sub-fossil horse material from Late Pleistocene and Holocene sites: continental Europe

For comparative purposes, material from several carefully selected continental European sites are utilised in the morphological study. As with the British/Irish material, measurable material available from continental European collections is listed for three separate chronological periods: 'Period 1' (table 5.4) includes sites of Mid-Late Weichselian age (excluding specifically Late Glacial sites), 'Period 2' (table 5.5) includes sites of Late Glacial and early Post Glacial age, and 'Period 3' (table 5.6) includes sites of mid-late Post Glacial (Late Mesolithic/Neolithic/Bronze Age and later) age. The present author has personally measured collections of Belgian, French and German horse material (sites listed in tables 5.4 and 5.5); however, additional data were collected from the literature in order to create more reliable comparisons with British/Irish material. Furthermore, although the majority of sites listed in tables 5.4-5.6 are located in continental north-west Europe, it was necessary to include sites beyond this region (e.g. Ukraine) for inter-regional comparative purposes.

Modern horse material

The modern comparative horse material (designated as Period 'Recent') can be seen in table 5.7 and includes selected individuals of various domestic breeds (*Equus caballus*), the Przewalski's horse (*Equus ferus przewalskii*), and the tarpan (*Equus ferus ferus*). Although a small sample of domestic horse material was chosen for inclusion in this study (table 5.7), the data are valuable for making proportional as well as body size comparisons. For example, pony and heavy horse data are useful for indicating the lower and higher ends of the spectrum with regard to dimensions reflecting body weight (e g long bone breadth measurements). Also, it must be noted that because only one complete skeleton of tarpan exists (see chapter 2), the published measurements of this individual ('Tarpan 521' = the Taurian tarpan otherwise known as the last true tarpan) must serve as representative data for the recent European "wild" type. On the other hand, modern wild Przewalski's horse skeletons are relatively ubiquitous and provide a homogeneous sample. Twenty individuals (table 5.8) have

Table 5 4. Measurable Horse Material from Continental European Sites for Period 1. Mid-Late Weichselian (excluding specifically Late Glacial sites)

Site Name	Country	Elements Measured	Source of Data
Camiac*	France	Pc; CT	Guadelli (1987, 1991)
Combe-Grenal*	France	Pc; CT	Guadelli (1987, 1991)
Jaurens*	France	Pc; CT	Guadelli (1987, 1991)
Kamenka*	Siberia	Pc; CT	Germonpre & Lbova (1996)
Mezin*	Russia	CT	Nobis (1971)
Pair-non-Pair*	France	Pc, CT	Guadelli (1987, 1991)
Solutré	France	Pc; CT	Original; Guadelli (1987, 1991)

Table 5.5. Measurable Horse Material from Continental European Sites for Period 2. Late Glacial/Early Post Glacial

Site Name	Country	Elements Measured	Source of Data
Andernach-Martinsberg	Germany	Pc, CT; Cr	Original
Bedburg-Königshoven	Germany	Pc	Original
Bruniquel (= Courbet)	France	Pc; CT; Cr	Original
Chaleux	Belgium	Pc; CT	Original
Gönnersdorf	Germany	Pc; CT; Cr	Original
Kartstein Abri	Germany	Pc	Original
Kettig	Germany	Pc	Original
Le Grand Canton*	France	Pc	Bémilli (1994)
Miesenheim II	Germany	Pc	Original
Pekárna-Höhle*	Czech Rep	Pc	Musil (1969)
Pont D'Ambon*	France	Pc	Uerpmann (1990)
Solutré	France	Pc; CT	Original; Guadelli (1987, 1991)
Stellmoor*	Germany	Pc	Rust (1943)

Table 5.6. Measurable Horse Material from Continental European Sites for Period 3: Mid-Late Holocene (Late Mesolithic/Neolithic/Bronze Age & later)

Site Name	Country	Elements Measured	Source of Data
Sites (x2) in Anatolia*	Turkey	Pc	Bokonyi (1991)
Bokarn*	Sweden	Pc	Lundholm (1947)
C. European sites (x5)*	e g. Germany	Pc	Müller (1993)
Calden*	Germany	Pc	J. Weinstock (pers comm)
Site nr. Weimar*	Germany	Pc	Barthel (1985)
Csepel-Haros*	Hungary	Pc	Nobis (1971)
Dereivka*	Ukraine	Pc; CT	Bibikova (1970); Nobis (1971); Anthony (1991)
Lövsta*	Sweden	Pc	Lundholm (1947)
Roucadour*	France	Pc	Uerpmann (1990)
Zambujal*	Portugal	Pc	Uerpmann (1990)

For tables 5 4-5.6: * denotes sites not listed in the gazetteers (chapter 4); entries in **BOLD**= radiocarbon dates available for horse Pc= Postcranials; CT= Cheek Teeth, Cr= Cranials

Table 5.7. Measurable Material from Modern Horses

Modern Animals	Elements Measured	Source of Data
Przewalski's horses (n = 20) (see table 5.8)	Pc; CT; Cr	Original, Eisenmann & Beckouche (1986); Dive & Eisenmann (1991)
Tarpan '521' (n = 1)	Pc, CT	Bibikova (1970), Nobis (1971); Anthony (1991)
Heavy Horses (n = 5)	Pc	Eisenmann & Beckouche (1986)
Ponies (n = 4)	Pc	Eisenmann & Beckouche (1986)

Pc= Postcranials; CT= Cheek Teeth, Cr= Cranials

Table 5.8. Details of the Przewalski's Horses which Provided Measurement Data for the Current Study

Current Author's No.	Museum No.	Museum	Age (yrs) & Sex (M/F)	Source of Measurement Data
1	*1907.7.2.1	NHM	6 (F)	Original
1a	*1907.5.15.1/2	NHM	6 (M)	Original
2	*1902.9.25.1	NHM	"Adult" (F)	Original
3	*1945.6.11.1	NHM	Adult (M)	Original
4	*1960.2.1.4	NHM	3 42 (F)	Original
5	*1961.5.10.2	NHM	32 (F)	Original
6	*1963.1.25.1	NHM	31.33 (M)	Original
7	1932-46	AC/MA	29 (F)	Eisenmann & Beckouche (1986); Dive & Eisenmann (1991)
8	1935-486	AC/MA	21 (M)	Eisenmann & Beckouche (1986); Dive & Eisenmann (1991)
9	1941-322	AC/MA	16 (F)	Eisenmann & Beckouche (1986); Dive & Eisenmann (1991)
10	1962-228	AC/MA	30 (M)	Eisenmann & Beckouche (1986); Dive & Eisenmann (1991)
11	1929-35	AC/MA	28 (M)	Eisenmann & Beckouche (1986); Dive & Eisenmann (1991)
12	1929-37	AC/MA	20 (F)	Eisenmann & Beckouche (1986); Dive & Eisenmann (1991)
13	1953-147	MU	16 (M)	Eisenmann & Beckouche (1986), Dive & Eisenmann (1991)
14	359	LD	13 (M)	Eisenmann & Beckouche (1986) Dive & Eisenmann (1991)
15	32686	NY	11 (M)	Eisenmann & Beckouche (1986) Dive & Eisenmann (1991)
16	90198	NY	3 (M)	Eisenmann & Beckouche (1986), Dive & Eisenmann (1991)
17	MCZ 51058	HV	5 (F)	Dive & Eisenmann (1991)
18	ZMA-981	AM	20 (M)	Eisenmann & Beckouche (1986)
19	1951-73	MU	21(F)	Fisenmann & Beckouche (1986)

*= right and left sides available for some elements; Age and sex data according to Stecher (1967) and museum information; Museum collections associated with Przewalski's horse skeletons: AC/MA= Museum National d'Histoire Naturelle, Paris, France AM= Zoological Museum, Amsterdam, The Netherlands, HV= Museum of Comparative Zoology, Harvard University, USA, LD= Rijksmuseum voor Natuurlijke Historie, Leiden, Belgium, MU= Zoologische Sammlung des Bayerischen Staates, Munich, Germany; NHM= The Natural History Museum, London, England, NY= American Museum of Natural History, New York, USA

been selected for use as the standard sample to which fossil and sub-fossil material (see above) will be compared

Although the majority of recent horse measurement data (domestics, tarpan and 13 Przewalski's horse individuals) are derived from the literature, original data can be provided. Measurements have been taken for seven individuals of Przewalski's horse (table 5.8), and in some cases, both right and left sides are available. Regarding the entire Przewalski's sample (n=20), these individuals were selected by the present author based on strict criteria:

- Each individual is of known age or status (e.g. 'adult') and known sex (see table 5.8 for age and sex data provided by Stecher (1967))
- The majority of individuals (n=18) are registered in the stud book for Przewalski's horses (see Stecher (1967) for stud book number and zoo name)
- Each individual provides measurements (original and published) which can be related directly and accurately to those taken for ancient specimens

Furthermore, the present author made a conscious attempt to select a standard sample consisting mainly of fully adult individuals (i.e. aged 4 years and over); however, at least two of the individuals are known to be subadults (table 5.8: numbers 4 and 16). This is not envisaged to cause a problem with the homogeneity of the sample; on the contrary, a standard sample including animals of varying ages- provided their identity is known -may be more representative of a 'natural' population of horses than one which comprises animals of exactly equal ages

5.2.2 Methods of study

Measurements

A wide range of measurements for cranial (including cheek teeth) and postcranial elements was obtained by the author, directly and from published measurements All original measurements are based on a combination of those suggested by Musil (1969), von den Driesch (1976), and Eisenmann *et al.* (1988). Published measurements on cheek teeth and postcranials were utilised only if they were consistent with those used by the present author.

For the cheek teeth, a number of basic measurements were taken for both uppers (11) and lowers (15). The second premolar (P2: anterior end of row) and third molar (M3. posterior end of row) were more easily identifiable due to their characteristic

forms; while the third premolar to the second molar (P3-M2: teeth of central part of row) were more difficult to separate especially when the effects of different wear stages were taken into account (see below). For the postcranials, a series of measurements was taken ranging from five on the ulna (a rare and relatively simple bone) to 22 on the third metacarpal (a common and informative bone) All measurements were obtained by the author using two sizes of vernier callipers (to the nearest 0.5mm and 0.02mm for large and small callipers, respectively). The resulting data were entered into *Microsoft Excel* spreadsheets for use in graphical and statistical analyses (see below).

In this chapter, the author has chosen to utilise only a limited number of element types in making comparisons. Element types were selected based on quantitative as well as qualitative factors. Some elements were relatively ubiquitous and well-preserved (e.g. metapodials, phalanges), whereas others were rare and poorly preserved (e.g. ulnae). Also, many measurements had to be discarded based on their continued repeatability and inconsistency. The key elements measured were: metapodia, first phalanges, tibiae, radiae, astragali and cheek teeth (upper P2s and M3s). See figures in Appendix 2 which detail all the relevant measurements presented in this chapter and illustrate how they were taken.

Cheek teeth measurements were incorporated primarily for the purpose of gauging variation between dental and postcranial elements. Also, the wear stage of individual specimens was determined using the method given in Eisenmann *et al.* (1988). Height (Ht) measurements of unworn upper P2s and M3s were divided by four to reveal the four stages of wear (groups 1-4). For example, if the maximum height of an upper P2 is 54.0mm, all the upper P2s measuring between 54.0 and 40.5mm would belong to stage 1, all those measuring between 40.5 and 27.0mm would belong to stage 2, all those measuring between 27.0 and 13.5mm would belong to stage 3, and all those measuring between 13 5 and 0.0mm would belong to stage 4. The present author took care to use stage 2 or stage 3 teeth in comparisons, as these are known to provide the most reliable occlusal measurements (Eisenmann *et al.*, 1988). Thus, measurements from teeth of very young or very old individuals (stages 1 and 4) were avoided

Standardisation and estimation

The methodology involved with standardising measurements is reviewed in detail by other authors (e.g. Simpson, 1941; Uerpmann, 1979, 1990; Meadow, 1984; Lister, 1993), and only a brief summary will be given here. These methods can be utilised as a means of gauging animal size in which ancient specimens are standardised in relation to corresponding elements of a standard individual (associated skeleton) or sample of individuals. The arithmetic difference between the measurement of a fossil specimen, and the corresponding measurement of the standard (or mean of the standard sample) is expressed as either a logarithm (i.e. log-ratio) or percentage (i.e. %size difference). This makes it possible to compare a range of samples irrespective of the precise composition (in terms of body-part representation) of each. This method has proved advantageous because it facilitates comparisons between small samples on a linear scale, thus allowing for more detailed contrasts between several different elements at once. It must be noted, however, that the method assumes that the proportions between different elements has remained constant. On the other hand, it can be used to investigate changes in those proportions. The author has chosen here to use the percentage method in which measurements are expressed as a percentage of the standard population mean (i.e. a sample of modern Przewalski's horses where the mean for each bone/tooth measurement has been calculated) (see table 5.9). In all graphs relating to these data, the percentage deviations are illustrated on univariate plots in which the zero line is the mean of a Przewalski's horse sample for each bone/tooth type.

The estimations of overall body size made here include estimations of body weight (or mass) and withers height in particular. Specific measurements of limb-bone depth and length were chosen for use in these comparisons because depth (i.e. antero-posterior diameter) dimensions for horse postcranial elements are known to scale closely with body weight (Alberdi *et al.*, 1995), and length measurements, especially those of individual long bones, correlate well with withers height (Kiesewalter, 1888; Vitt, 1952; von den Driesch and Boessneck, 1974). The author has chosen to utilise the methods of Kiesewalter (1888) (table 5.10) and Alberdi *et al.* (1995) (table 5.11) for estimating the withers heights and body weights of modern and ancient animals.

Table 5 9. Method Used for Gauging Animal Size

Percentage Method (after Lister, 1993)
For Postcranials and Cheek Teeth: $\frac{X_m - \overline{X}_{prz}}{\overline{X}_{prz}} * 100$ = percentage difference from sample mean
X_m = particular measurement for horse bone/tooth specimen $\overline{X}_{prz}$ = Przewalski's horse sample mean for corresponding measurement

Table 5.10. Method Used for Estimating Horse Withers Heights (WH)

Kiesewalter (1888) Method [WH= X * factor]	
For Third Metacarpals (MCIII): WH = "LL" * 6.41	For Third Metatarsals (MTIII): WH = "LL" * 5.33
X = measurement (lateral length ["LL" or L1] used here) factor = Kiesewalter's (1888) measurement factor for a given element	

Table 5.11. Method Used for Estimating Horse Body Mass/Body Weight

Alberdi *et al.* (1995) Method [$\ln Y = \ln a + b \ln X$]	
For Third Metacarpals (MCIII): $\ln Y = -4.490 + 2.916 \ln X$	For Third Metatarsals (MTIII): $\ln Y = -4.061 + 2.768 \ln X$
Y = body mass or weight X = measurement (depth of distal keel [Ddk] used here) $\ln a$ and b = variables as given in Alberdi *et al.* (1995)	

Graphing and statistics

Measurement data were used to construct univariate (e.g. percentage difference) and bivariate (e.g. x-y scatter) plots which are employed below to aid in the size and shape descriptions of relevant horse finds/samples. Statistical analyses were performed on data exported from spreadsheets. Student's t-test was applied where appropriate in order to determine whether two samples are likely to have come from the same two underlying populations that have the same univariate mean. All analyses incorporate two data sets, and unless designated otherwise, all tests were two-tailed and assumed unequal sample variance. Results are given as the probability (p) associated with Student's t. A probability of 0.05 or lower is conventionally taken as statistically significant.

5.3 Discussion of morphological variation in relation to chronology

5.3.1 Introduction

First, it is necessary to get a clear picture about the body size and proportions of the ancient horses which are relevant to the current project. In the first instance, the morphology of British/Irish horses within each of the three key periods described above will be assessed in chronological order. A further assessment of morphology will then be made between animals of different chronological periods. Finally, British/Irish horses can be compared with those from continental Europe for all chronological periods. Measurements of modern animals (e.g. Przewalski's horse) will be employed throughout for comparative purposes.

5.3.2 Britain and Ireland

It is a commonly accepted and well-documented view (e.g. Eisenmann, 1988; Forsten, 1988) that changes in size took place in European wild horses of the Late Pleistocene (Mid-Late Devensian/Weichselian) and early Holocene The current project aims to compare these noticeable changes in continental horses with those in Britain and Ireland.

A comparison was made among horse postcranials within each of the three key periods Also, breadth measurements from first phalanges, metapodials (MCIII and MTIII), tibiae, astragali and radii were compared using the method of percentage variation from the mean of a standard 'population' (a sample of modern Przewalski's

horses) (figs. 5.1-5.3a,b). Breadth (i.e transverse diameters) and depth measurements were exclusively chosen for use in this comparison in order not to combine measurements which reflect two different aspects of body size, namely 'body weight or mass' and 'body height' (i.e. withers height in horses). As mentioned in section 5.2.2, breadth/depth measurements scale closely with body weight, while length measurements of long bones correlate well with withers height. According to Scott (1990) and Lister (1993), because breadth measurements of certain postcranials "each have very similar scaling relationships to body size", they should "remain roughly isometric to each other" when animal body size fluctuates. This is advantageous when a range of postcranial measurements are being utilised to describe variations in animal body size (Lister, 1993).

Mid-Late Devensian horses (fig. 5 1) are of a medium-large body size with the majority of elements retaining a high percentage (+10-25%) deviation from the Przewalski's horse mean. Material from sites such as Kent's Cavern (Devon) and Fisherton (Wiltshire) is consistently larger than the Przewalski's horse mean. Several of the sites represented (e.g. Kent's Cavern; Shandon Cave, Co. Waterford) have yielded horse material which has been directly-radiocarbon dated to this period, however, only one site (Elderbush Cave, Staffordshire) has yielded a radiocarbon dated element (MCIII: OxA-6320, 33,050 ±1000 BP) which can be pinpointed on figure 5.1. Many of those specimens which either lie close to the zero line or unexpectedly into the negative percentages, have rational supporting explanations. For example, elements from Conningbrook Pit (Kent), are smaller than the Przewalski's horse mean. This variation at the site suggests that stratigraphically younger, probably Late and Post Glacial, horses are likely to be present within an assemblage which is assumed to be exclusively Mid-Devensian in age (see chapter 4) Another explanation may be that Mid-Devensian horses are variable, perhaps more variable than those of other Pleistocene periods. This may have been due to the transitional nature of their era, one which saw both severe and rapid environmental (i e. climatic and vegetational) changes upon its shift to the Late Glacial Interstadial (see chapter 3). On the other hand, because some of these sites have ambiguous stratigraphic sequences, it is possible that undated material is not the age it appears to be (i e it could be much older [Middle Pleistocene] or much younger [later Holocene]) See below for a discussion of the size differences between Mid-Devensian, Late Glacial and Post Glacial horses.

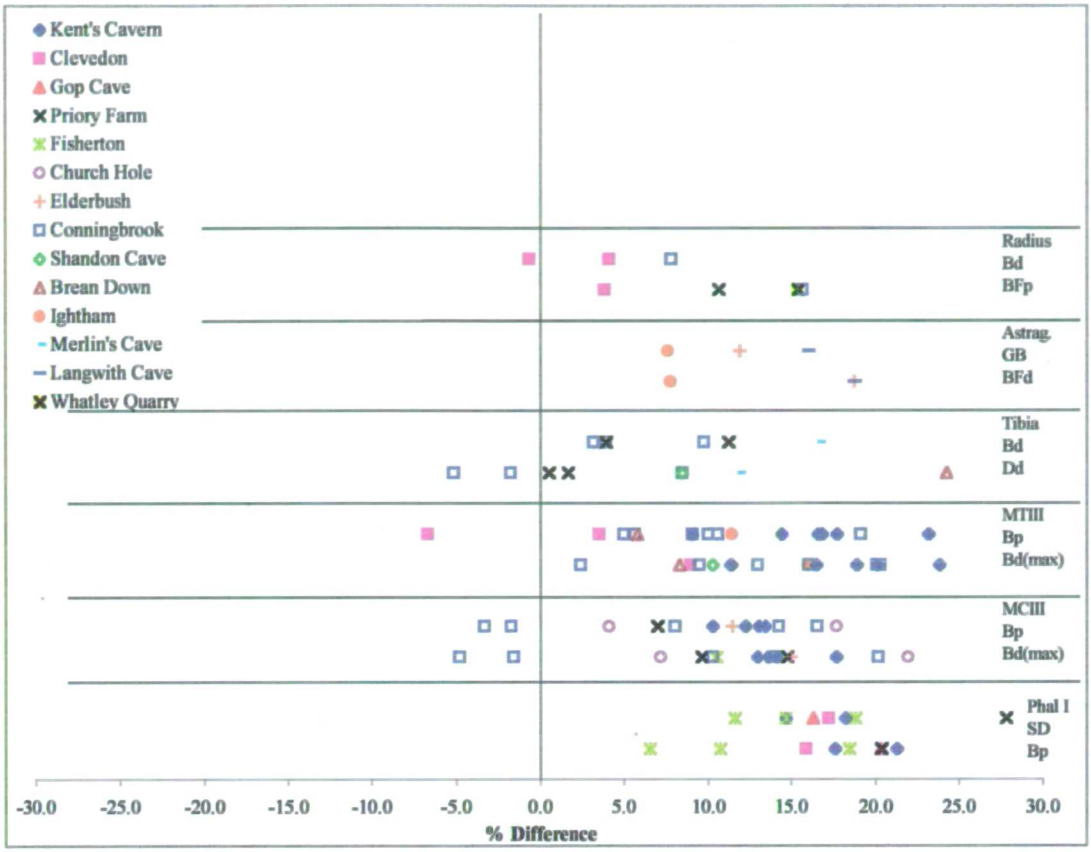

Fig. 5.1. Percentage difference from a "standard" for horse postcranials from British Mid-Late Devensian (excluding Late Glacial) sites where the zero line is the mean of a Przewalski's horse sample (phal I (fore/hind): n=46; metapodials: n=24; tibia/astragalus/radius: n=12).

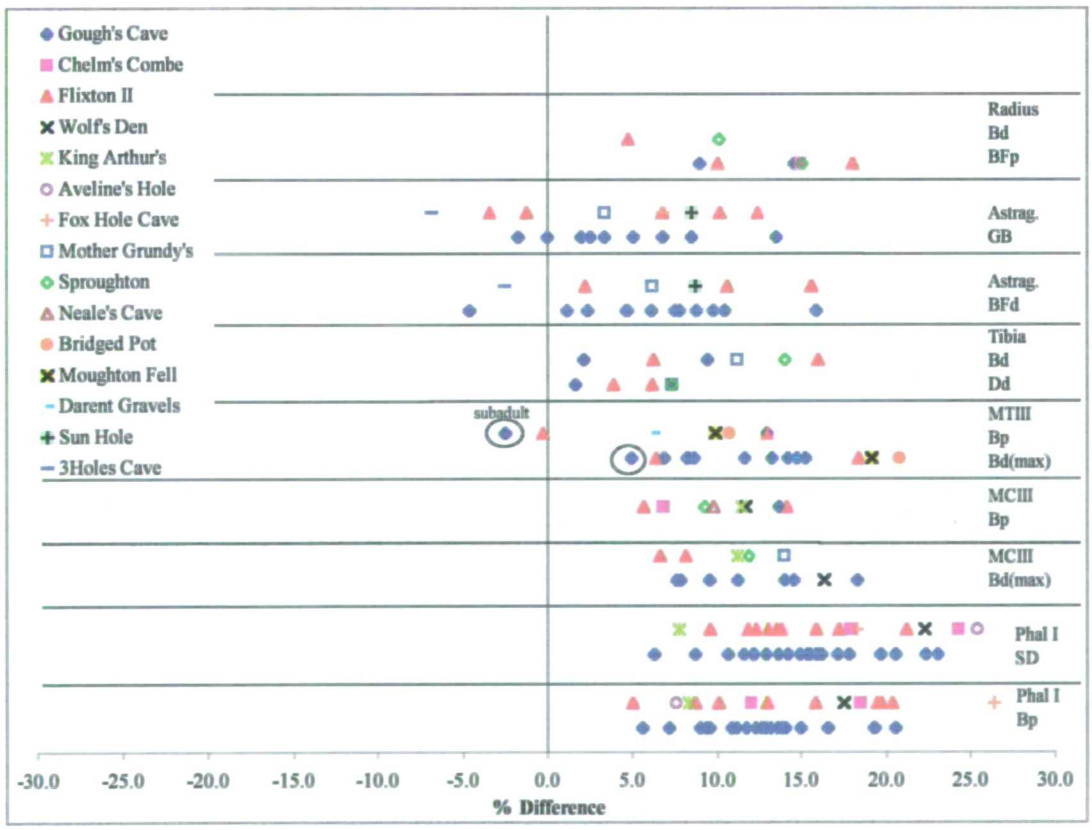

Fig. 5.2. Percentage difference from a "standard" for horse postcranials from British Late Glacial/early Post Glacial sites where the zero line is the mean of a Przewalski's horse sample (phal I (fore/hind): n=46; metapodials: n=24; tibia/astragalus/radius: n=12).

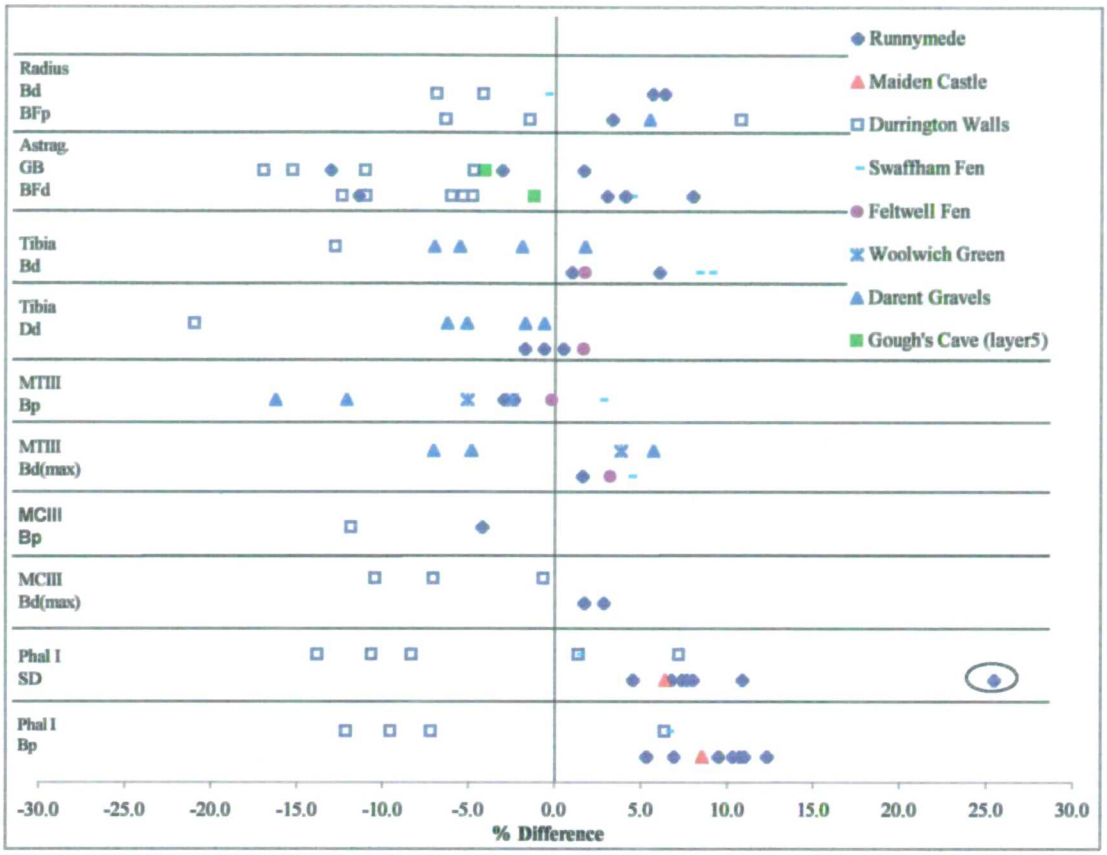

Fig. 5.3a. Percentage difference from a "standard" for horse postcranials from British mid-late Post Glacial sites where the zero line is the mean of a Przewalski's horse sample (phal I (fore/hind): n=46; metapodials: n=24; tibia/astragalus/radius: n=12). Sites listed have dated horse material.

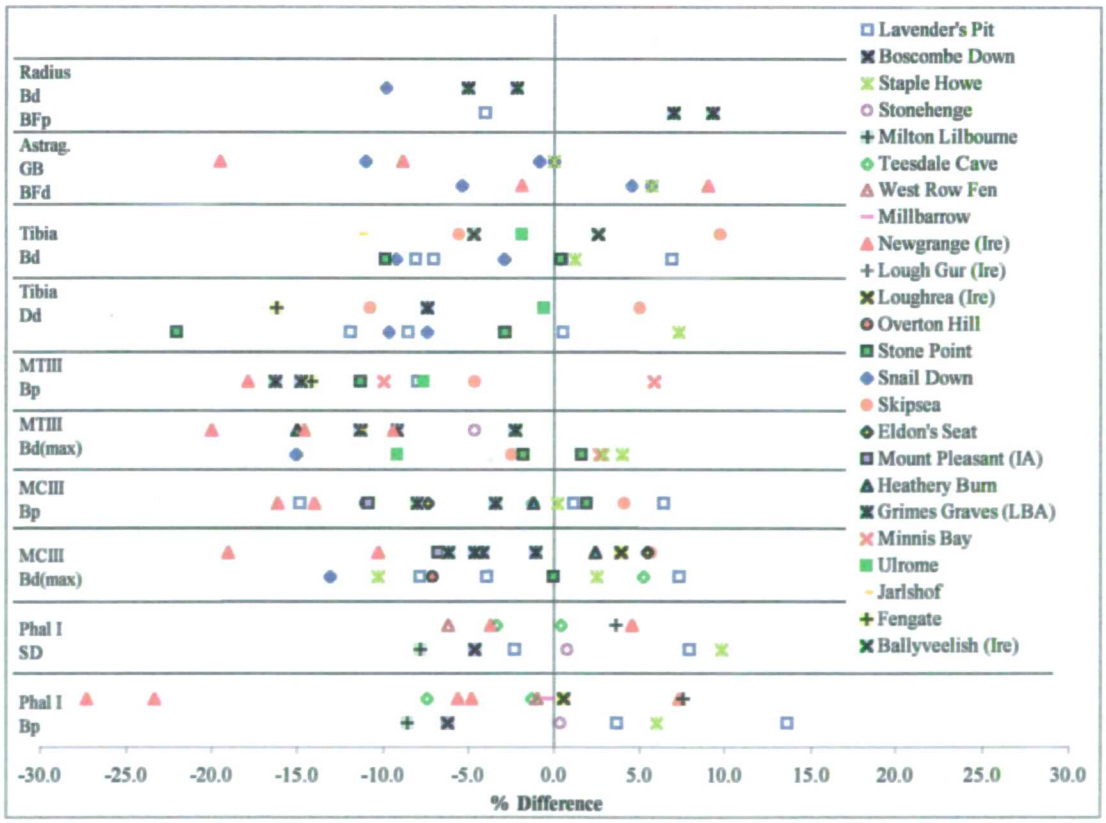

Fig. 5.3b. Percentage difference from a "standard" for horse postcranials from British/Irish mid-late Post Glacial sites where the zero line is the mean of a Przewalski's horse sample (phal I (fore/hind): n=46; metapodials: n=24; tibia/astragalus/radius: n=12). Sites listed have no dated horse material.

Table 5.12. T-testing data (2-tailed, 2-sample unequal variance) for First Phalanges (Phal I) of Przewalski's Horses and Late Glacial Horses of Britain

Phal I (fore only) 'Smallest Breadth of the Diaphysis' [SD]
Przewalski's Horse (n=23) vs. Gough's Cave (n=8): UK Bølling
p= 0 000000030
Phal I (hind only) 'Smallest Breadth of the Diaphysis' [SD]
Przewalski's Horse (n=23) vs. UK Younger Dryas (n=4)
p= 0.000000001

In contrast to the Mid-Devensian material, it is possible to give a more complete overview of British Late Glacial/early Post Glacial horse material. Because this material is the central focus of the current project, more material was available for analysis. Also, as was mentioned in chapter 4, more direct radiocarbon dates are available for the horses of this period, thus making morphological comparisons more meaningful regarding their precise chronology. Figure 5.2 incorporates many of the key Late Glacial/early Post Glacial sites which have yielded horse material. In fact, every site listed in figure 5.2 has a directly-dated horse specimen associated with it (see Appendix 1).

In relation to percentage variation from the Przewalski's mean, it is clear that the majority of the 'Period 2' material in figure 5.2 is larger than the sample mean by between +5-20%. More detailed comparisons can be made for specific time intervals. For the Younger Dryas (c. 11,000-10,000 BP), four key forelimb specimens are available from Flixton II (N. Yorkshire), Aveline's Hole (Somerset), Chelm's Combe (Somerset) and Wolf's Den (Somerset). With respect to the measurement 'SD' (smallest breadth of the diaphysis) for the first phalange, t-testing gives a significant difference between these and the modern Przewalski's sample (see table 5.12).

In addition, a few first phalanges from Gough's Cave (Somerset) also lie at this higher range. At least one specimen (at +20.55%) is known not to be of Younger Dryas age (i.e. dated to c. 12,400 BP: Bølling age), and it is also possible that the others are not since no Gough's Cave horse dates lie within this period. On the other hand, the existence of Younger Dryas horses at Gough's Cave cannot be ruled out by this negative evidence For example, positive evidence for a Younger Dryas assemblage at Gough's Cave is available in the form of dates for non-horse fauna (e g. reindeer dated c. 10,000-10,500 BP: Appendix 1). Furthermore, there are at least five sites (e g. Aveline's Hole, Chelm's Combe, Wolf's Den, Bridged Pot, Sun Hole) located

in the same region (i.e. Region 9: see table 5.2) which have all yielded Younger Dryas horses (see Appendix 1). Thus, further radiocarbon dating of these larger, more robust specimens from Gough's Cave may help to provide the supporting evidence needed to test for the existence of Younger Dryas horses at this well-known 'Region 9' site.

In figure 5.2, at the other end of the range (i e. in the negative percentages), several specimens are represented. Three separate explanations can be suggested to account for these bones appearing to be more gracile than other specimens of Late Glacial age. These explanations involve: 1) The ontogenetic age of individual animals and their preservation; 2) Security and accuracy of stratigraphic provenance; and 3) Genuine variation in size between differently aged material within Period 2 (i.e. the Late Glacial/early Post Glacial). A clear example of (1) can be found in the third metatarsal group where one particular Gough's Cave specimen (see chapter 4: fig. 4.4) is consistently at the smallest end of the range (i.e. in both proximal and distal width measurements) for Late Glacial/early Post Glacial horses. After studying this bone thoroughly, the author has come to the conclusion that it is from a young (i.e. subadult) animal based on the retention of certain physical indicators such as the porous nature of the bone surface, especially at or near the epiphyses. Regarding point (2), the known stratigraphic provenance of specimens sometimes is not accurate enough to date specimens. For example, an astragalus specimen from Three Holes Cave was known to have originated in the Late Glacial deposit at the site; however, figure 5.2 clearly shows that it is the smallest bone in the other measurement for breadth 'GB'. It has been suggested to the author (A. Roberts, pers. comm.) that this bone may instead be part of the Post Glacial assemblage (i.e. Bronze Age) at Three Holes, so this morphological information serves as supporting evidence that this bone is probably not of Late Glacial age.

Finally, point (3) provides an opportunity to employ both morphological and chronological methods to gain the greatest amount of information about Late Pleistocene and Holocene horses. Flixton II, a site in N. Yorkshire now known to have yielded both Late Glacial and early Post Glacial horses, is a good case in which two sets of data illustrated in figure 5 2 seem to support variation in size between the latest Pleistocene (i e Younger Dryas) horses and those of the early Holocene (i e Boreal) Two astragali (both radiocarbon dated) and two third metatarsal (both undated) specimens from Flixton II are at the centre of this case. The larger of the two astragali (+12.35‰ for 'GB' on fig. 5.2) dates to the Younger Dryas (c. 10,200 BP: OxA-6328)

while the other, much smaller one (-1.20% for 'GB' on fig. 5.2) dates to the Boreal period (c. 9,200 BP: OxA-6329). It is possible that this is significant because the two undated metatarsals appear to repeat the same pattern (i.e one is significantly smaller relative to the other: 'Bp' for the only two Flixton specimens on fig. 5.2). This pattern suggests that the difference in both sets of bones is genuine and reflects a change in size from the larger Late Glacial horses to a slightly smaller 'type' found in the early Post Glacial of northern England. Furthermore, in support of this theory, it is expected that the two measurements ('GB' for astragalus and 'Bp' for MTIII) should vary isometrically in view of the fact that these elements lie in such close anatomical proximity (i.e. the astragalus lies near the proximal end of the MTIII. see Appendix 2). For a further discussion of this issue and continental evidence of variation in size from Late Glacial to Post Glacial horses see section 5.3.3.

For ease of comparison, it was necessary to separate the Post Glacial material into two groups: 1) particular British sites which have yielded securely dated horse specimens (i.e. rated I or II) (fig. 5.3a); and 2) all other sites (both British and Irish) without dated horse specimens (i.e. rated II or III) (fig.5.3b). In contrast to figure 5.2 for Late Glacial/early Post Glacial horses, figures 5.3a and 5.3b depict Post Glacial horses which appear to be significantly smaller with the majority of specimens extending below the Przewalski's horse sample mean (i.e. 0 to -20%). However, there are many specimens which extend above the mean, but only up to c.+10% with one notable exception (on fig 5.3a) being a first phalange from Runnymede Bridge (Surrey) which appears to be as big as some Late Glacial (Younger Dryas) phalanges (i.e. c.+25% for 'SD').

There seem to be at least two theories to explain the unusual size of the Runnymede specimen. Firstly, it is possible that this bone belongs to a stratigraphically older (i e. Late Glacial) deposit which somehow has become incorporated into the younger (Late Bronze Age) deposits at the site. Another theory, however, relates to the fact that its 'Bp' (proximal breadth) measurement is not significantly different to those from the other Runnymede horses Consequently, this specimen may truly belong to the Post Glacial assemblage, but be unusually large with respect to its diaphysis breadth. Moreover, when this particular bone is compared to a Late Glacial fore phalange from Chelm's Combe which is similar to the rogue Runnymede bone in the 'SD' measurement, the Runnymede specimen is found to be significantly different in its 'Bp' (i e Runnymede bone is c.+10% while the Chelm's bone is c.+18%) This

evidence of variation indicates that this large Runnymede specimen comes from a domestic horse which may have been selectively bred (see below). On the other hand, if this horse was not a domesticate it could mean that small populations of the more 'robust' wild horses were still present in Britain during the later Post Glacial. This hypothesis, however, is difficult to support with only one piece of morphological evidence. The present author therefore proposes that a reliable radiocarbon date for this bone would be necessary provide further vital information in solving this problem.

The Post Glacial horses in figure 5.3a range in age from c. 3,000 BP (Durrington Walls, Wiltshire: first phalange) to c. 600 BP (Swaffham Fen, Cambridgeshire: first phalange) and there appears to be a significant amount of variation both within and between sites. For example, the well-known site of Durrington Walls has yielded a good sample of Post Glacial horses with a wide range of variation. If the newly dated phalanges are considered, the variation is clearly represented on figure 5.3a. The largest (+6.39% for 'Bp', +7.24% for 'SD') of the phalanges has yielded, not surprisingly, the oldest of the dates at 3,045 ±50 BP (OxA-6653), while one of the smallest (-9.54% for 'Bp', -13.80% for 'SD') has yielded a date almost one thousand years younger (2,090 ±45 BP: OxA-6614). This difference is size is thought to be significant even though this comparison involves a fore (older) versus a hind phalanx (see chapter 4: fig. 4.5).

An example of inter-site variation can be elucidated in the comparison of two dated bones: a third metatarsal from Darent Gravels, Kent (BM-1618R: 1,060 ±120 BP) and a fore first phalange from Maiden Castle, Dorset (OxA-6657: 1,015 ±40 BP). Interestingly, even though these two specimens are almost contemporaneous they do not appear to be in the same size range (fig. 5.3a). The Maiden Castle bone lies well within the size range for older specimens (e.g. Runnymede and Durrington dated to c. 3,000-2,800 BP), while the Darent Gravels bone appears at the smallest end of the range for metatarsals (i.e. -7.03% for 'Bd (max)', -16.24% for 'Bp'). The extent of this variation seems to be indicative of the range of body sizes (expressed as body mass) which must have been present among domestic horses in Britain during the Post Glacial.

Figures 5.4-5.7 which combine data from the three key periods clearly demonstrate that a progressive reduction in size took place from the Mid-Devensian through the Late Glacial to the Post Glacial in Britain. However, there seems to be some overlap in size between the Middle and Late Devensian periods (figs. 5.4 and

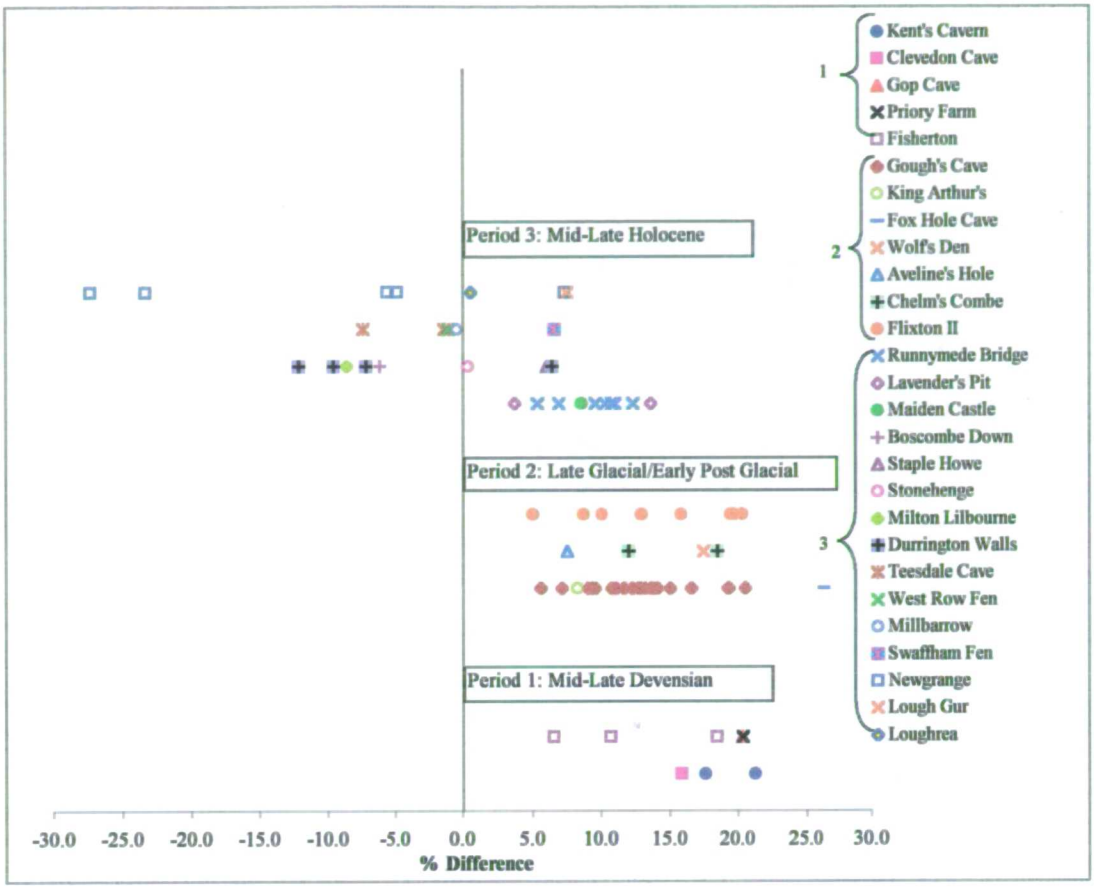

Fig. 5.4. Percentage difference from a "standard" for horse first phalanges (fore/hind: measurement 'Bp') from British/Irish Late Pleistocene and Holocene sites where the zero line is the mean of a Przewalski's horse sample (n=46).

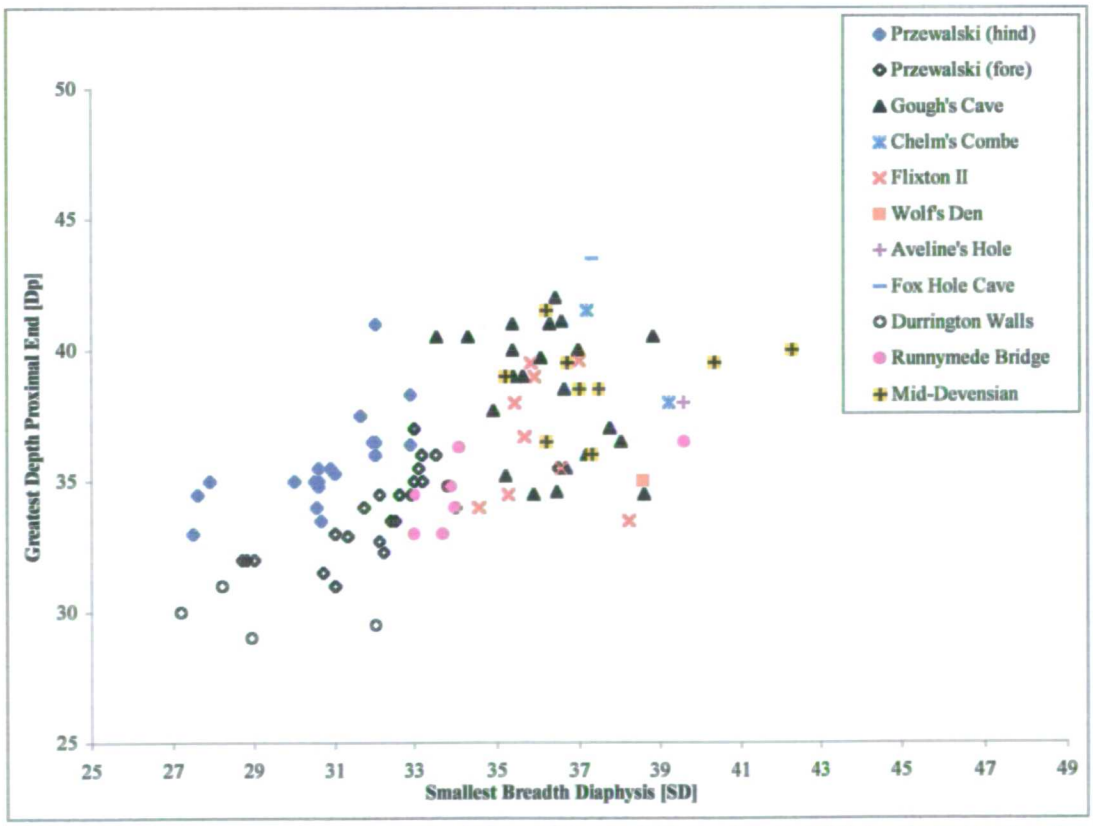

Fig. 5.5. First phalanx (fore & hind) proportions in Late Pleistocene/Holocene horses of Britain. A sample of modern Przewalski's horse phalanges has been included for comparison.

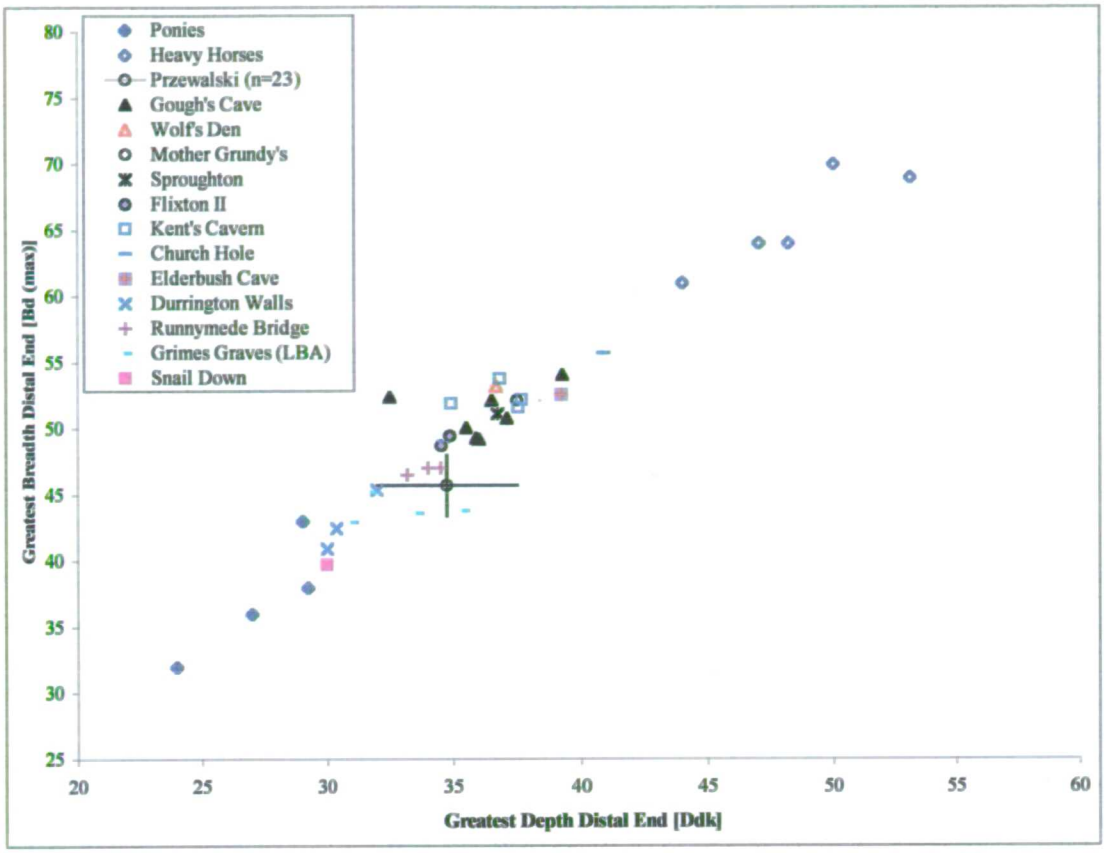

Fig. 5.6. Third metacarpal (MCIII) proportions in Late Pleistocene/Holocene horses of Britain. Samples of modern Przewalski's horses, ponies and heavy horses have been included for comparison. The Przewalski's sample (n=23) is represented by one point (the mean) with min/max range bars.

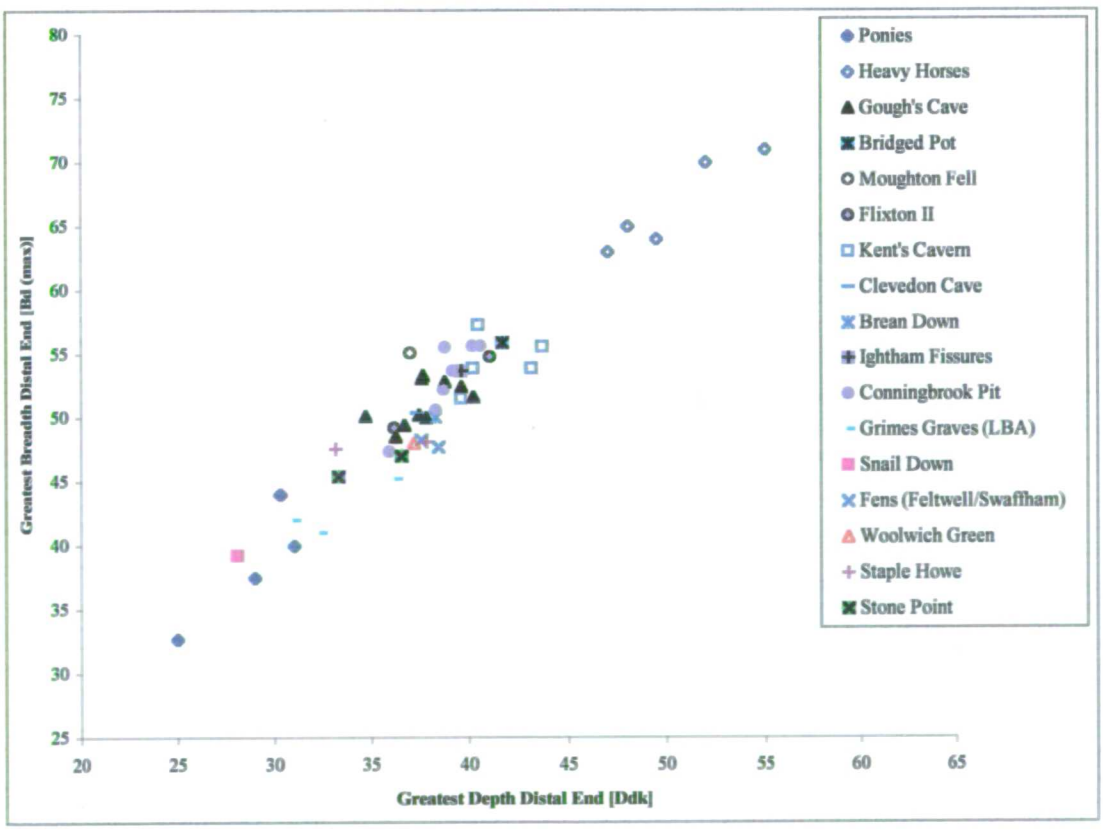

Fig. 5.7. Third metatarsal (MTIII) proportions in Late Pleistocene/Holocene horses of Britain. Samples of modern ponies and heavy horses have been included for comparison.

5.5). For example, some Mid-Devensian material (e.g. Kent's Cavern) is grouped at the larger end of the range for Late Glacial material (e.g. some, but not all Gough's Cave and Flixton II material). In taxonomic terms, this transition has been categorised by continental workers (e.g. Guadelli, 1987) as the transition from '*E. c. gallicus*' (Middle Weichselian form) to '*E. c. arcelini*' (Late Weichselian or Late Glacial form). In Britain, the size comparison of material from Kent's Cavern (Mid-Devensian) and Gough's Cave (Late Glacial) appears to correspond approximately with the '*gallicus*' to '*arcelini*' transition. However, see section 5.3.3 for a further discussion of this issue as well as actual size comparisons with '*gallicus*' and '*arcelini*' holotype specimens from Solutré, France.

Figures 5.4, 5.6 and 5.7 show a further reduction in size which can be interpreted in terms of the existence of Post Glacial domestic horses (*E. caballus*) which have been mentioned above. Horse material from British/Irish Post Glacial (i.e. Beaker/Bronze Age and later) sites such as Newgrange (Co. Meath), Durrington Walls (Wiltshire), Snail Down (Wiltshire), Grimes Graves (Norfolk), Staple Howe (N. Yorkshire), and Runnymede Bridge (Surrey) appear smaller in body size (i.e. body weight as expressed by long bone diameter) in comparison to the Mid-Devensian and Late Glacial horses. Pony and heavy horse measurements were utilised in order to create body size comparisons with familiar modern horse 'types/breeds'. Thus, certain bone measurements (e.g. distal metapodial breadths) of some of the earliest domestic horses in Britain appear only to be slightly larger than those of ponies. However, although this indicates a similar body weight as today's ponies, it appears that not all Post Glacial horses were of the same stature (i.e. withers height as expressed by long bone length). Many of these British Post Glacial horses have long bones (i.e. metapodials) which are the same length or longer than some of Late Glacial age. However, in the width measurement (i.e. 'Bd (max)' or distal greatest breath), many of the Post Glacial horses are far inferior and more in line with those of a sample of modern Przewalski's horse (see figs. 5.8 and 5.9). So, it appears that British Post Glacial horses were less sturdy (i e. more gracile) than those of earlier periods even if some individuals were not that much shorter at the withers. Furthermore, some evidence of variation in form of Post Glacial horses themselves is shown by different metapodial proportions between sites such as Runnymede Bridge (more robust) and Lavender's Pit and Stone Point (more gracile) (see figs. 5.8 and 5.9). It is possible that this is further evidence reflecting the selective breeding of early domesticates during

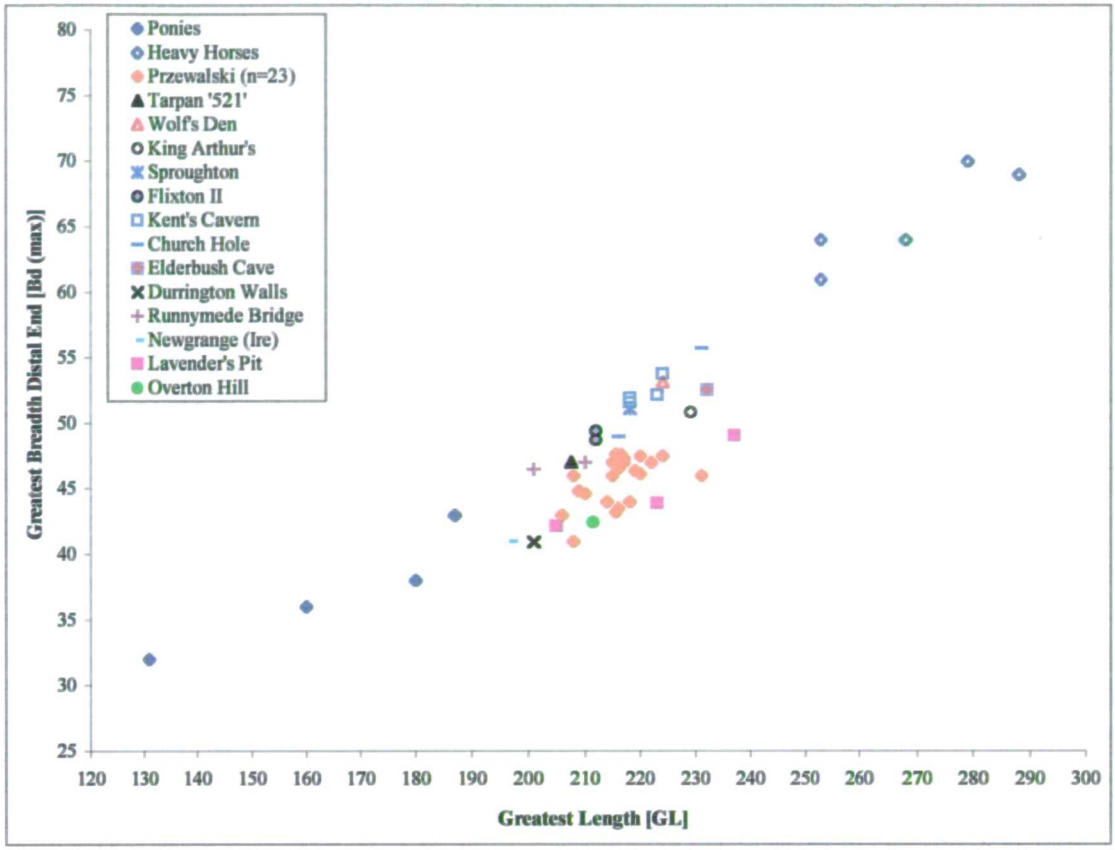

Fig. 5.8. Third metacarpal (MCIII) proportions in Late Pleistocene/Holocene horses of Britain and Ireland. Samples of the tarpan, modern Przewalski's horses, ponies and heavy horses have been included for comparison.

Fig. 5.9. Third metatarsal (MTIII) proportions in Late Pleistocene/Holocene horses of Britain and Ireland. Samples of modern Przewalski's horses, ponies and heavy horses have been included for comparison.

the middle to later Post Glacial in Britain. Also, it is conceivable that during this late period, domestic horses of varying sizes were being imported from other regions (see sections 5 4 and 5.5).

5.3.3 Continental Europe

As with the British and Irish fossil/sub-fossil horses, it is first necessary to introduce the subject material. Unlike the descriptions given above, however, these accounts are neither complete nor definitive because of their use solely for comparisons. Using measurements (both original and published) of first phalanges and metapodials from selected continental European sites dating to the three key periods, it is possible to get an overview of the size and shape of the horses which lived in closest proximity to those of Britain and Ireland during the Late Pleistocene and Holocene.

Similar to the British case described in section 5.3.2, figure 5.10 shows a combination of Mid-Weichselian (older) and Late Glacial (younger) material which is clearly larger than the same comparative sample of Przewalski's horses used in figures 5.4 and 5.5. Again, there appears to be an overlap of older (i.e. Solutré [Perig/Aurig], France) and younger (e g. Solutré [Magd], France; Chaleux, Belgium) material at the larger end of the phalange size range. It must also be pointed out that the sole Younger Dryas representative (from Kartstein-Abri, Germany) is markedly larger than the hind phalanges of supposed Bølling age. As a result of a lack of Younger Dryas dates for the Late Glacial sites represented in figure 5.10, it is currently unknown whether any of the other larger Late Glacial specimens also date to this terminal Late Glacial period.

A comparison of metapodial distal ends for the three key periods (figs. 5.11 and 5.12) shows a congregation of points intermediate between modern ponies and heavy horses. Again, the material from Periods 1 and 2 (i.e. Mid-Weichselian and Late Glacial/early Post Glacial) represents animals which appear to be larger (i.e. heavier or more robust) than a sample of modern Przewalski's horses. The Late Glacial material (e g Bruniquel, Chaleux, Gönnersdorf, Andernach, Solutré[Magd]) seems to group together and the majority of specimens appear to be smaller than both the Pair-non-Pair '*germanicus*' and the Jaurens '*gallicus*' (i e Mid-Weichselian) samples. Thus, the transition from '*germanicus*' (up to Early Weichselian) through '*gallicus*' (Mid-Weichselian) to '*arcelini*' (Late Weichselian) seems apparent, although with some evidence of overlapping. Furthermore, it is necessary to highlight the position of three particular Late Glacial/early Post Glacial specimens on figure 5 12. A specimen from

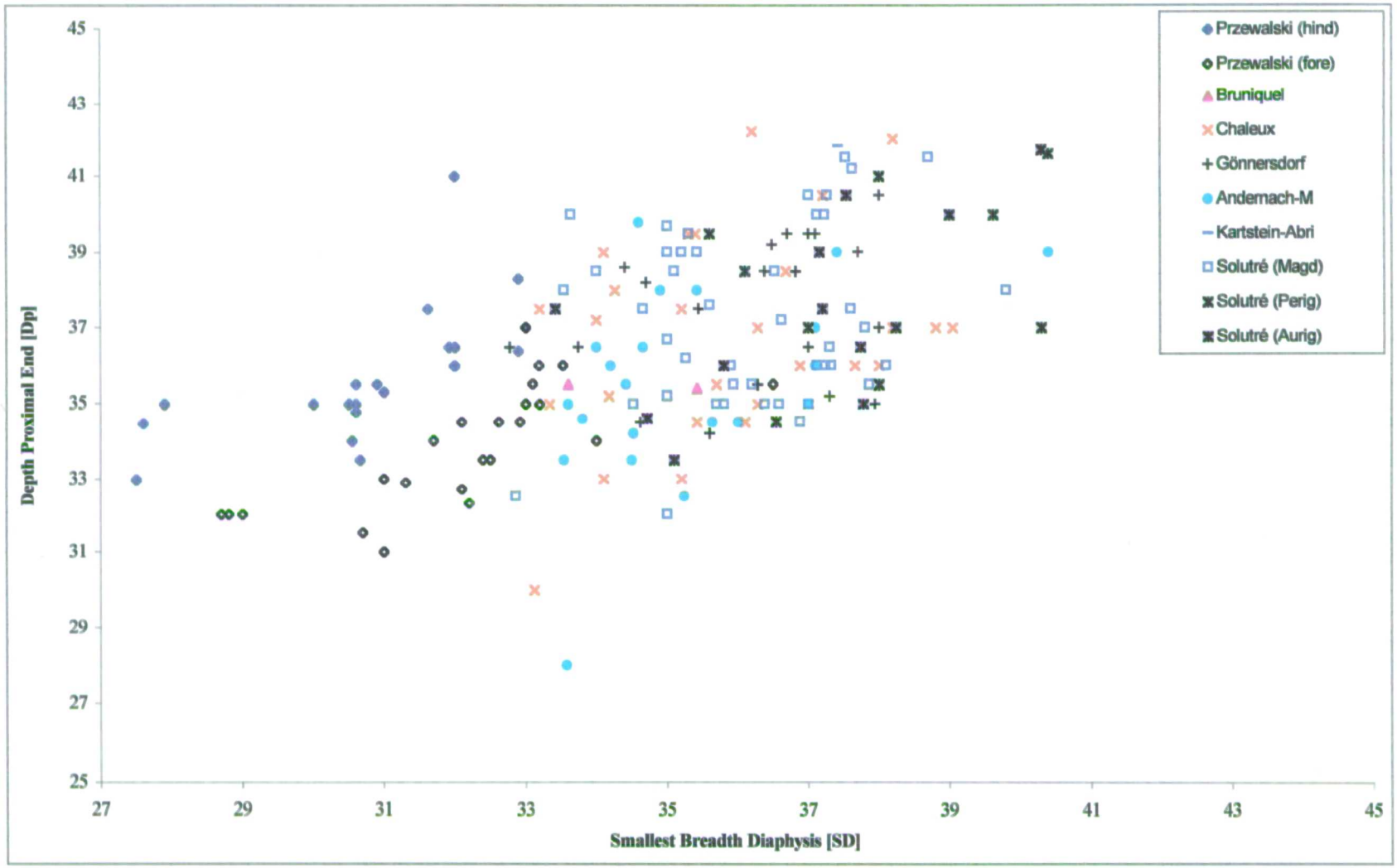

Fig. 5.10. First phalanx (fore & hind) proportions in Late Pleistocene horses of continental Europe. A sample of modern Przewalski's horse phalanges has been included for comparison. (For Solutré samples: Magd= Magdalenian; Perig= Perigordian; Aurig= Aurignacian).

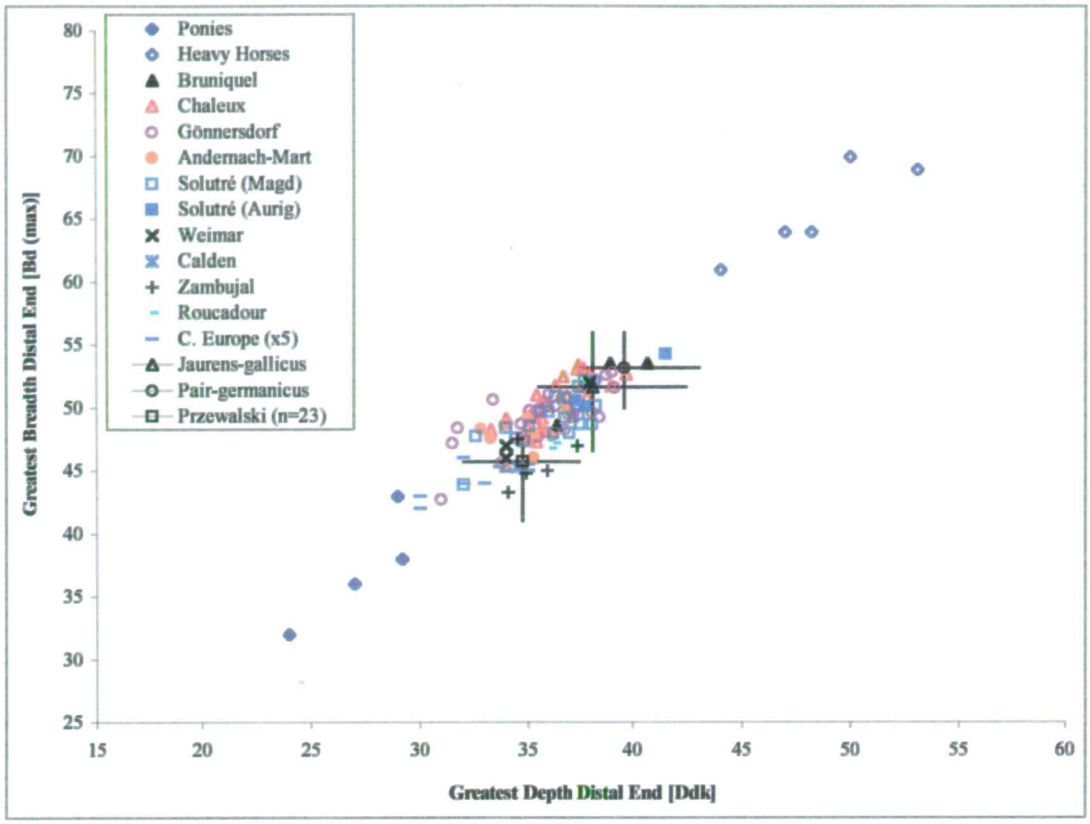

Fig. 5.11. Third metacarpal (MCIII) proportions in Late Pleistocene/Holocene horses of continental Europe. Samples of modern Przewalski's horses, ponies and heavy horses have been included for comparison. The Przewalski's (n=23) and Late Pleistocene samples from Jaurens (n=32) and Pair-non-Pair (n=24) are represented by one point (the mean) with min/max range bars. Number in parentheses (x*) indicates number of sites sampled.

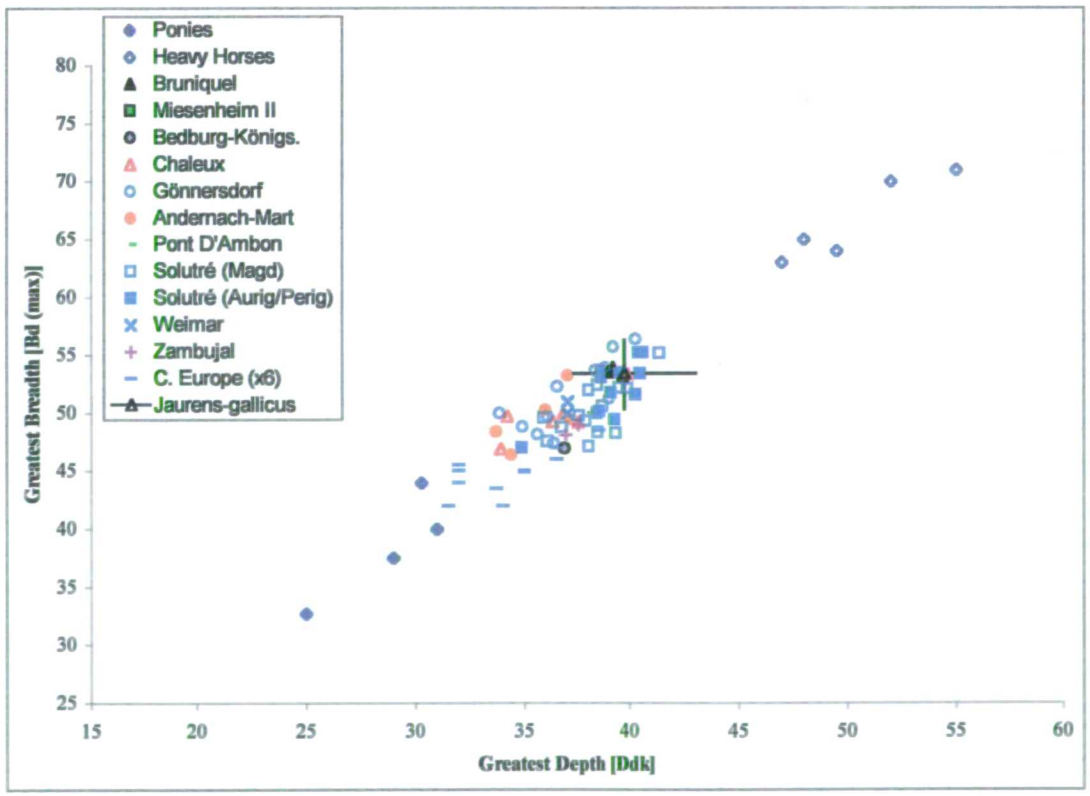

Fig. 5.12. Third metatarsal (MTIII) proportions in Late Pleistocene/Holocene horses of continental Europe. Samples of modern ponies and heavy horses have been included for comparison. The Late Pleistocene sample from Jaurens (n=29) is represented by one point (the mean) with min/max range bars. Number in parentheses (x*) indicates number of sites sampled.

the Allerød deposits at Miesenheim II (Germany) appears to be very large with respect to the majority of other Late Glacial material, and it seems to group with the Mid-Weichselian material. Also, the two known early Post Glacial specimens from deposits at Pont D'Ambon (France) and Bedburg-Kónigshoven (Germany) appear to lie within the middle and lower ends of the Late Glacial range, respectively. Although variation in size through the Late Glacial and early Post Glacial (i.e. Period 2) appears to be evident in figure 5.12, it is necessary to attach a note of caution to this hypothesis as this key material has yet to be directly radiocarbon dated (rated II or III). In contrast to the above, Post Glacial horses of continental Europe appear to be smaller relative to those of the Late Glacial (figs. 5.11 and 5.12). In addition, there appears to be a further progressive size reduction within the Post Glacial group of horses from the middle through to the later parts of this period. For example, some of the Neolithic material (e.g. Weimar, Germany; Roucadour, France) lies at the larger end of the Post Glacial range, in contrast to a selection of Late Bronze Age material (e g. central European sites) which are only just larger than modern ponies. See section 5.4 for comparisons with British/Irish horses of the same period.

Figures 5.13 and 5.14 show proportional differences between continental material from the three key periods. For the third metacarpals, the Mid-Weichselian (i.e. '*gallicus*' holotype specimen from Solutré), Late Glacial and early Post Glacial material appears to lie on a separate line for 'Bd(max)' (e g. 'y = 0.1881x + 8.8694' for Solutré[Magd]) to that of specimens from particular Post Glacial sites (e.g. 'y = 0.1077x + 22.158' for Sweden[x2]) (fig 5 13). A similar picture is evident for third metatarsals in figure 5.14 where the line for Late Glacial material (e g. 'y − 0.0767x + 29 911 for Solutré[Magd]) differs from that of some Post Glacial material (e.g. 'y = 0 0843x + 24 417' for Sweden[x2]). On the other hand, Neolithic material from sites such as Dereivka (Ukraine) and Weimar as well as Beaker material from the Hungarian site of Csepel-Háros lie on a similar 'Bd(max)' axis to material from continental north-west European Late Glacial sites even though the specimens vary enormously in greatest length ('GL'). Interestingly, the progressive size reduction through time seen in western European Post Glacial material appears also to be evident within eastern European material, where the older (i.e Neolithic) Dereivka material is markedly larger than that of the younger (i e Beaker age) Csepel-Háros. Furthermore, it is necessary to mention briefly the position of Tarpan '521' (a modern "wild" type) relative to the ancient European material (fig 5.13). This specimen appears to lie at the

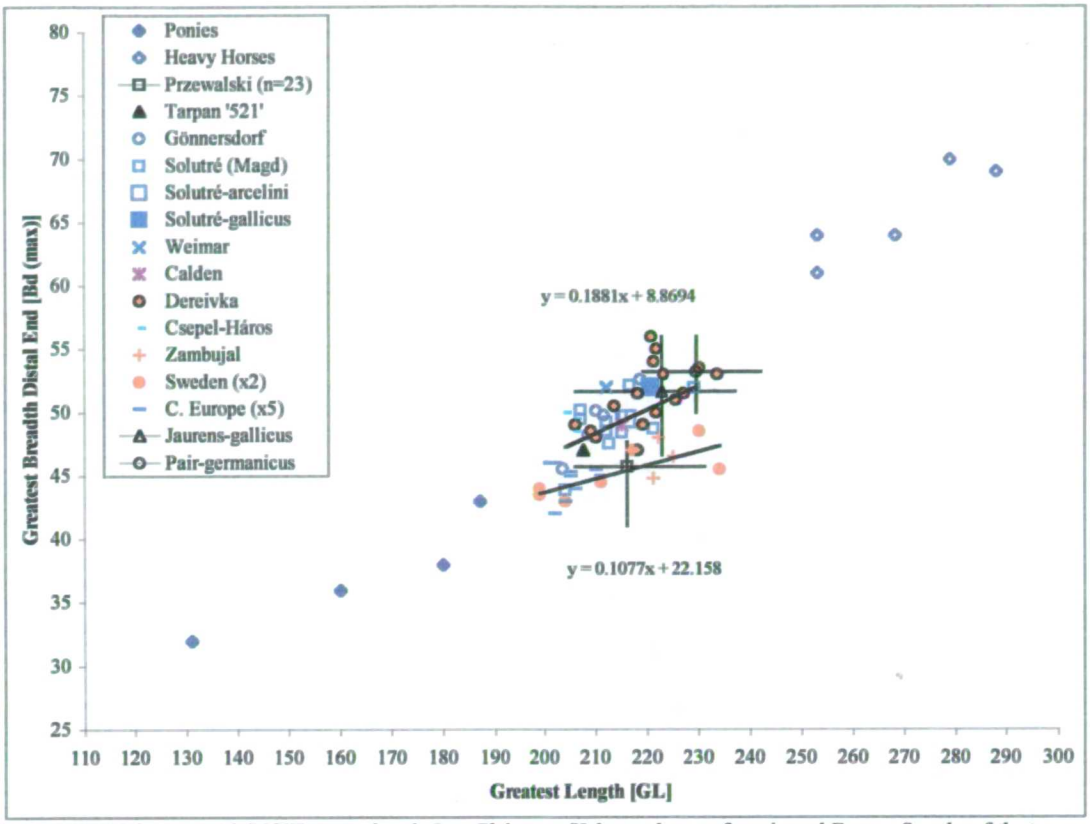

Fig. 5.13. Third metacarpal (MCIII) proportions in Late Pleistocene/Holocene horses of continental Europe. Samples of the tarpan, modern Przewalski's horses, ponies and heavy horses have been included for comparison. The Przewalski's (n=23) and Late Pleistocene samples from Jaurens (n=33) and Pair-non-Pair (n=24) are represented by one point (the mean) with min/max range bars. Number in parentheses (x*) indicates number of sites sampled.

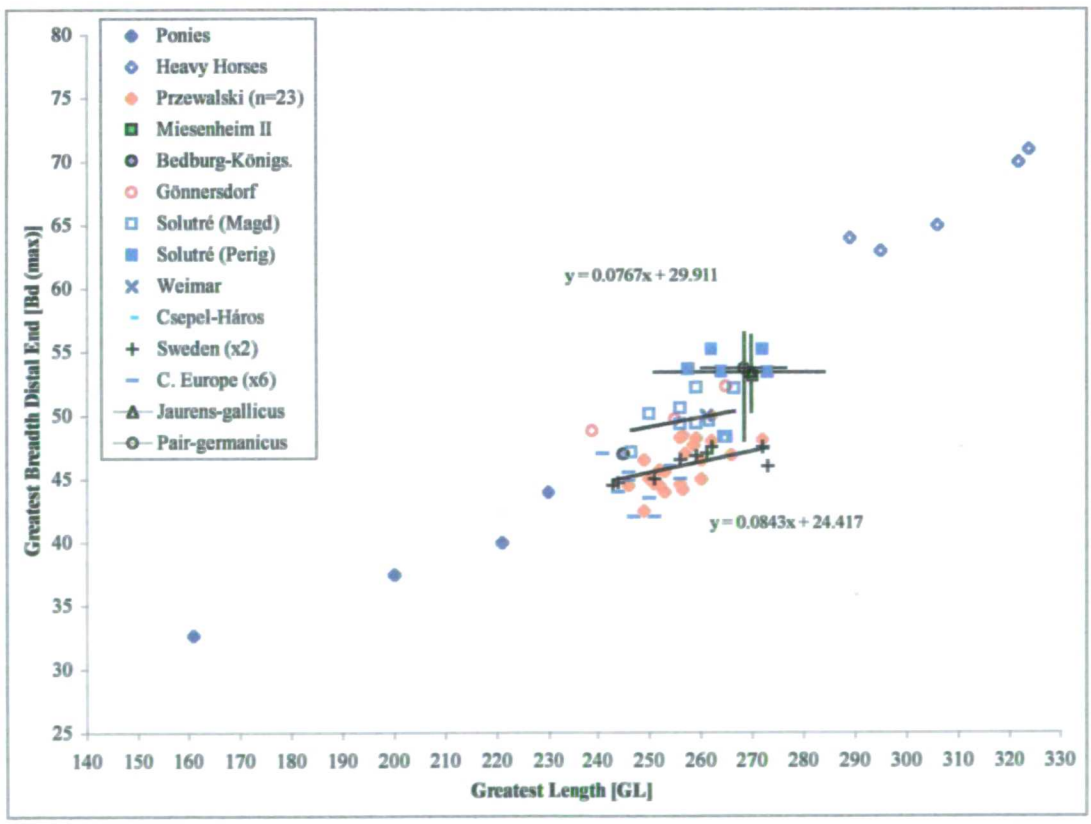

Fig. 5.14. Third metatarsal (MTIII) proportions in Late Pleistocene/Holocene horses of continental Europe. Samples of modern Przewalski's horses, ponies and heavy horses have been included for comparison. The Late Pleistocene samples from Jaurens (n=30) and Pair-non-Pair (n=25) are represented by one point (the mean) with min/max range bars. Number in parentheses (x*) indicates number of sites sampled.

smallest end of the range for the eastern European Post Glacial material; however, its distal breadth is more gracile than the Csepel-Háros horses while being more robust than the majority of western and central European Post Glacial horses as well as the modern Przewalski's horses. See below (section 5.3.4) for a further discussion of these eastern European horses.

Once more, proportional differences can be seen in figure 5.14 for the third metatarsals. It now appears even more clear, within Period 2, that there is reduction in size between an Allerød (Miesenheim II) and a Pre-Boreal/Boreal (Bedburg-Königshoven) animal (see chapter 4: fig. 4.6). Both body mass and withers height (i.e. stature) are extreme in the Miesenheim horse, whereas the Bedburg horse can be regarded as a 'dwarf' in comparison. With regard to other Post Glacial material depicted in figure 5.14, the middle Post Glacial western, central and eastern European material is in line with that of the western Late Glacial material, while western and central European Bronze Age material from Sweden and Germany appears to be in line with the Przewalski's sample. A further discussion of this and other size variation issues as well as comparisons with British horses will be given below.

5.3.4 Morphological comparisons: Britain/Ireland versus the Continent

The aim of this section is to make size contrasts between British/Irish and continental horse material. It must be noted, however, that the main aim here is to create direct comparisons between assemblages belonging to the three key periods (i.e. chronological comparisons) Other types of comparisons encompass a geographical aspect in which British/Irish material is firstly contrasted to that from key western continental European sites, and secondly, to that from other more easterly situated continental sites. It has already been established in sections 5 3.2 and 5.3.3 that both British and continental Late Pleistocene material follow the model of progressive size reduction from the Devensian (Weichselian) to the Late Glacial/early Post Glacial. Adherence to the model in which there is a transition from the more robust '*E. c. gallicus*' (in Period 1) to the more gracile '*E. c. arcelini*' (in Period 2) suggests some consistency in overall change in size (i e. gradual size decrease with time) across north-west Europe. It must also be stressed that the detailed size comparisons presented in the current work provide additional data regarding other, previously undetected, changes in size which took place during the environmentally turbulent Period 2 (i e. Late Glacial/early Post Glacial) for both regions. Furthermore,

consistency has also been detected for a further decrease (and variation) in body size through to the later Post Glacial (Period 3). The end of Period 2 (i.e early Post Glacial) as well as the early to middle of Period 3 are the intervals for which Uerpmann (1990) proposes the use of four regional subspecies of *E. ferus* ('*silvestris*', '*lusitanicus*', '*ferus*', and '*scythicus*') for the populations which supposedly existed across the whole of continental Europe (west to east). Interestingly, Uerpmann (1990) does not attempt to incorporate the British early Post Glacial wild horses into this scheme. Thus, by comparing British and continental material directly, the current author expects to supplement the European model. However, because no wild horses are thought to have existed in Britain during Period 3 (see chapter 4 and below), British horses may have to be excluded from the European scheme given above. See chapter 6 (section 6.4) for a further discussion of this issue.

Regarding the earliest period to be considered in the current work (i.e. the Mid-Devensian or Weichselian), data (figs 5.15 and 5.16) support the view that horses dating to this period in both Britain and continental north-west Europe correlate well with respect to size. Also, in comparison to the holotype specimens for '*gallicus*' and '*arcelini*' (third metacarpals only), it appears that, as expected, the British material groups with the more robust '*gallicus*' (fig. 5.15). However, as mentioned above, the small size of some British material (Conningbrook Pit) suggests a mixed stratigraphy at the site which resulted in younger material (i.e. more gracile) having become incorporated into older deposits.

A great deal more can be said for the size of Late Glacial/early Post Glacial horses of the two regions. In general, it appears that populations from both regions correlate well with regard to size (figs. 5 16-5.18). Also, during this period, it is clear that the variety of horse samples seems to correlate more closely with the '*arcelini*' rather than the '*gallicus*' holotype (fig. 5.17). On the other hand, when discrete chronology is taken into account there are significant differences in size which can be elucidated. For example, although the Bølling samples from continental north-west Europe (e g Solutré (Magd), Gönnersdorf, Andernach-Martinsberg) do not differ significantly from one another, the British samples (e.g. Gough's Cave, King Arthur's Cave, Mother Grundy's Parlour) appear larger in comparison (see table 5 13). It is possible that this difference in size is the result of an environmental effect A further discussion of the implications arising from these findings is given below in section 5.4.

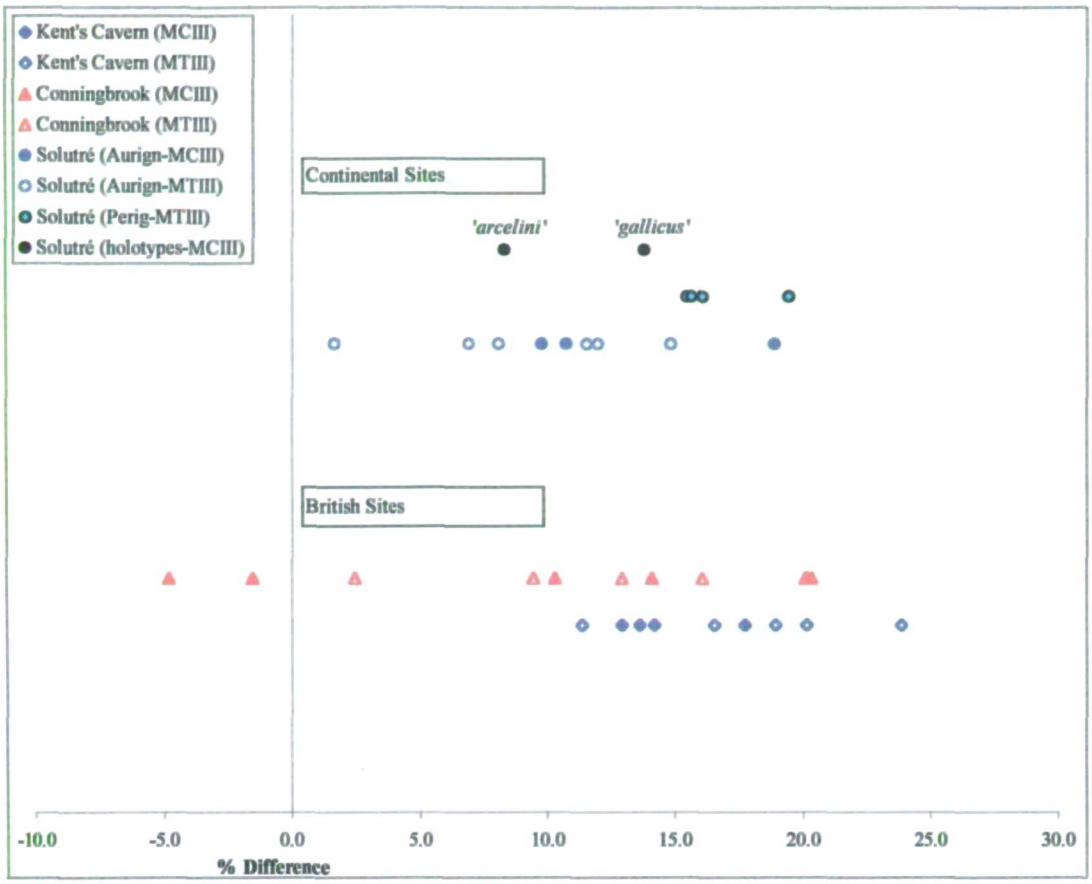

Fig. 5.15. Percentage difference from a "standard" for horse metapodials (measurement 'Bd(max)') from British and continental European Mid-Devensian (Weichselian) sites where the zero line is the mean of a Przewalski's horse sample (n=24).

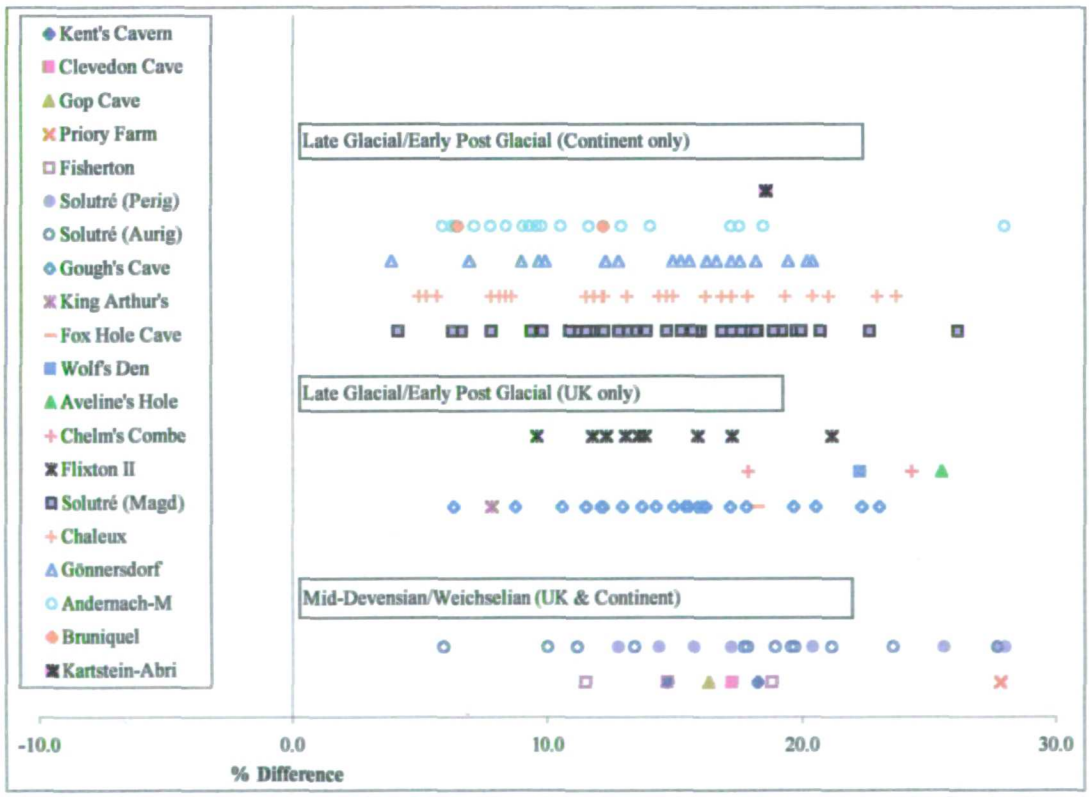

Fig. 5.16. Percentage difference from a "standard" for horse first phalanges (fore/hind: measurement 'SD') from British and continental European Late Pleistocene/early Holocene sites where the zero line is the mean of a Przewalski's horse sample (n=46).

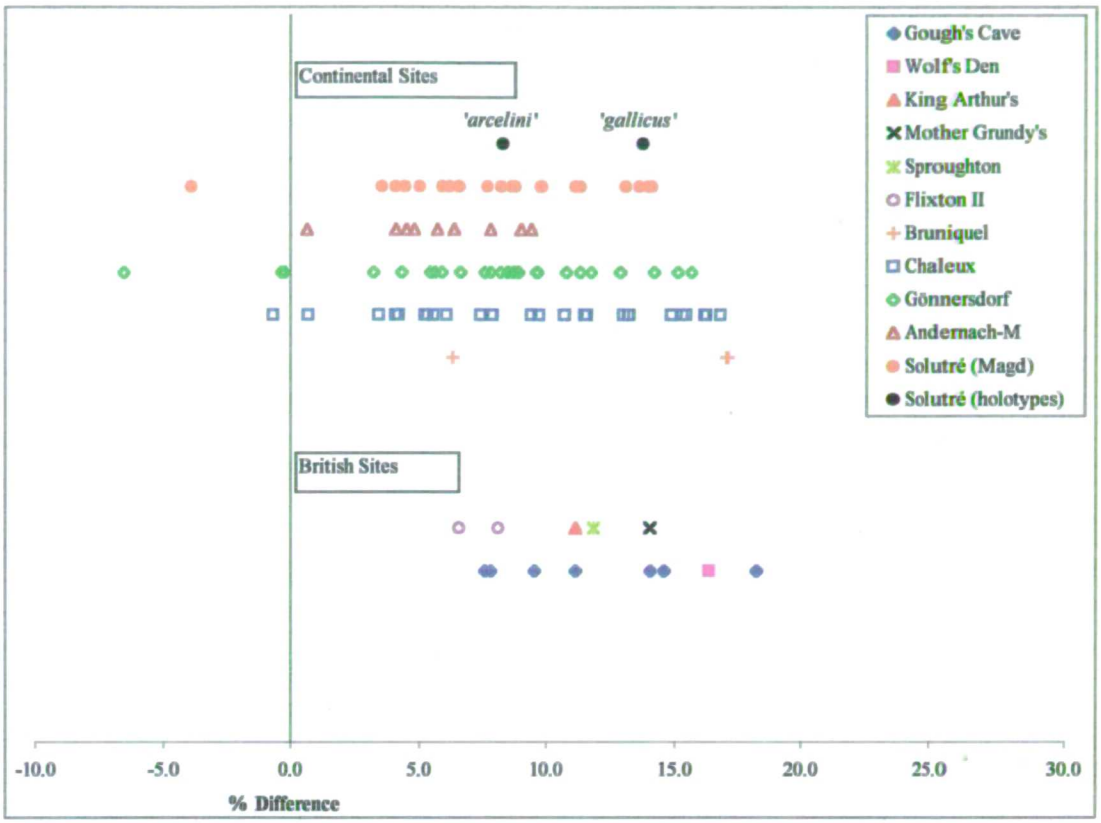

Fig. 5.17. Percentage difference from a "standard" for horse third metacarpals (measurement 'Bd(max)') from British and continental European Late Glacial/early Post Glacial sites where the zero line is the mean of a Przewalski's horse sample (n=23).

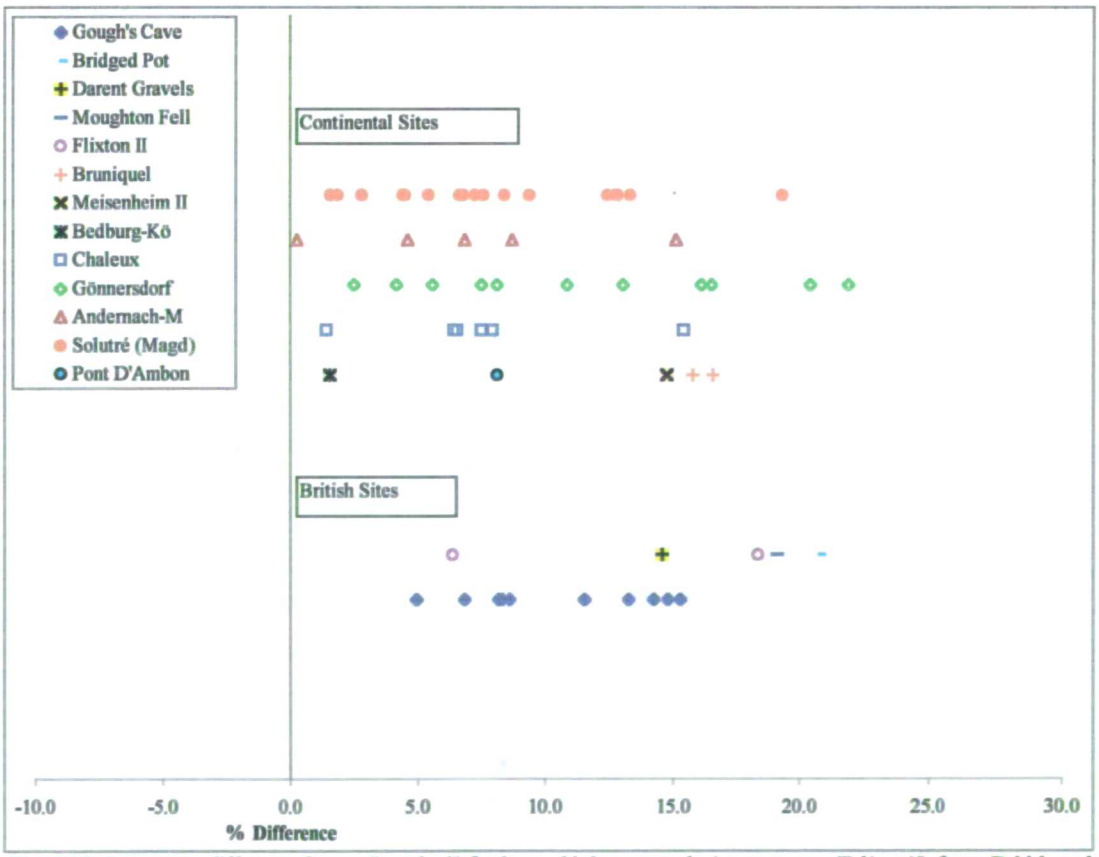

Fig. 5.18. Percentage difference from a "standard" for horse third metatarsals (measurement 'Bd(max)') from British and continental European Late Glacial/early Post Glacial sites where the zero line is the mean of a Przewalski's horse sample (n=24).

Table 5.13. T-testing data (2-tailed, 2-sample unequal variance) for Third Metacarpals (MCIII) of Late Glacial Horses of Britain and Continental Europe

MCIII 'Greatest Breadth of the Distal End' [Bd(max)]
Gough's Cave (n–7), King Arthur's Cave (n=1), Mother Grundy's Parlour (n=1) vs. Andernach-Martinsberg (n–9) p= 0 0008
Gough's Cave (n=7), King Arthur's Cave (n–1), Mother Grundy's Parlour (n=1) vs. Solutré (Magd) (n=22) p= 0.0123
Gough's Cave (n=7), King Arthur's Cave (n=1), Mother Grundy's Parlour (n=1) vs. Gönnersdorf (n=27) p= 0 0112
Gönnersdorf (n=27) vs. Andernach-Martinsberg (n=9) p= 0.1398
Gönnersdorf (n=27) vs. Solutré (Magd) (n=22) p= 0.9445

The next chronological interval of interest is the Allerød (c. 12,000-11,000 BP), and although only two sites (one per region) are available for this comparison, it is novel one. Two third metatarsals, from Miesenheim II (Germany) and Moughton Fell (N. Yorkshire), are quite clearly of a similar large size; however, again the British one is slightly more robust (fig. 5.18). It must be noted that the German bone is undated (rated II), while the British one is now known to date (rated I) to the very end of the Allerød (c. 11,100 BP) and groups with other British supposedly Younger Dryas (rated II) bones (e g. Flixton II). In cases such as this, however, it is necessary to clarify that the author realises that 'slight' differences, with sample sizes of only 'n=1', could be as a result of sampling error. On the other hand, if confirmed by larger samples, this difference between British and continental material could either be as a result of a geographical or chronological effect.

Regarding the British Younger Dryas material represented on figures 5.17 and 5 18, it is again clear that metapodial specimens (e.g. Flixton II, Wolf's Den) dated to this interval lie at the larger end of the range for European Late Glacial horses Furthermore, it is possible to compare British with continental material of Younger Dryas age. The more robust of the British specimens (directly dated to this interval: rated I) can clearly be seen in figure 5.16, as can one robust phalange (undated. rated II) from Kartstein-Abri (Germany) Because these phalanges are markedly larger than

Table 5.14. T-testing data (2-tailed, 2-sample unequal variance) for First Phalanges (Phal I) of Late Glacial Horses of Britain and Continental Europe

Phal I (fore only) 'Smallest Breadth of the Diaphysis' [SD]
Gough's Cave (n=8) vs. Chelm's Combe (n=1), Aveline's Hole (n=1), Wolf's Den (n=1), Flixton site II (n=1)
p= 0.0035
Phal I (hind only) 'Smallest Breadth of the Diaphysis' [SD]
Gough's Cave (n=14) & Fox Hole Cave (n=1) vs. Chelm's Combe (n=1) & Kartstein Abri (n=1)
p= 0.0017

those of the Bølling and significance testing (table 5.14) shows the difference to be significant, this pattern appears to correspond to 'Bergmann's Rule' of larger size in colder climate (see section 5.4).

Furthermore, at least three interesting, alternative themes are brought to the fore regarding particular Period 2 dated specimens. Firstly, there appears to be a difference in size between the two third metacarpals from Sproughton and Wolf's Den even though their dates lie only c. 200 years BP apart (fig. 5.17). However, because the modern Przewalski's sample population exhibits a 10-15% range around the mean (i.e. 'zero line'), a c. 5% difference for the Late Glacial sample cannot be considered as significant. Also, the availability of such a small sample prompts the author to make only an extremely cautious interpretation with regard to an indication of a geographical effect within Britain during the Younger Dryas (see section 5.4).

Another interesting scenario arises with bones such as the third metatarsal from Darent Gravels (Kent) which has been directly dated to the early Post Glacial (c. 9,800 BP or Pre-Boreal) and the continental specimen from Pont D'Ambon (France) which, according to Uerpmann (1990), dates to the same interval (i.e. the deposit dates to c. 9,600 BP). Interestingly, the British specimen, once again, is the larger (fig. 5.18). Again, however, a c. 7% difference within a population cannot be considered as significant (see above).

Finally, the latest interval of Period 2 (i.e. the Pre-Boreal/Boreal: c. 9,600-9,000 BP) provides one further interesting comparison. The continental site of Bedburg-Königshoven (Germany) and the British site of Flixton II (N. Yorkshire) are both known to have yielded deposits with Boreal faunal material. One small Flixton II horse specimen (an astragalus· see above) has been directly dated to this interval (c. 9,200 BP) and it appears that size variation detected in other bones (e.g. third metatarsals· fig

5.18) may fit the model of gradual size decrease with time (i.e. Younger Dryas to Boreal). A similar pattern is evident with respect to the German material in which a Miesenheim II (Allerød) specimen is markedly larger in comparison to a bone from Bedburg (possibly dating to the Boreal: M. Street, pers. comm) (fig. 5 18 and see chapter 4: fig. 4.6). If this detected size decrease with time is accepted as genuine, a pattern seems apparent regarding Late Glacial to early Post Glacial change in wild horse size from a larger, more robust animal in the Allerød/Younger Dryas through a slightly smaller one in the Pre-Boreal to an even smaller, more gracile one in the Boreal. Furthermore, as mentioned above, it appears that the British material is larger than that of the Continent when contemporaneous material is directly compared (fig. 5.18).

The Post Glacial (i.e. Period 3) material from the Continent and Britain/Ireland can be compared on many levels. Firstly and most importantly, it is necessary to highlight size comparisons with regard to material from the more westerly situated continental sites (e.g. France, Sweden, Portugal, Germany). The secondary aspect involves size comparisons with horses from more easterly situated sites (e.g. Hungary, Ukraine). Figures 5.19 and 5.20 depict these variations between British/Irish and continental material from selected sites which date to different intervals of Period 3. There does not appear to be a pattern of chronological size decrease for the British/Irish material; however, it must be noted that not all of this material is reliably dated (i.e. some are only rated II or III) Also, because the earliest Period 3 material (i.e. securely dated to the Late Neolithic from Grimes Graves) is insufficient for detailed body size assessment, the most useful dated material comes from later intervals (i.e. Beaker/Bronze Age and later). Thus, it is impossible to directly compare British Neolithic material with that of continental sites. Instead, it is possible to highlight the size of continental material in comparison with later material from both regions. For example, it is clear from figure 5 19 that the British (e g. Runnymede Bridge, Durrington Walls, Grimes Graves), Swedish and German (e g. five sites = 'C. Europe') Bronze Age material is smaller in comparison to the German (Calden and Weimar), Portuguese (one Zambujal, at +3 94%) and French (one Roucadour, at +3.28%) Neolithic/pre-Bell-Beaker specimens. On the other hand, it is must be noted that the British Bronze Age material appears to correlate well in size with contemporaneous material from Sweden and Germany (see above).

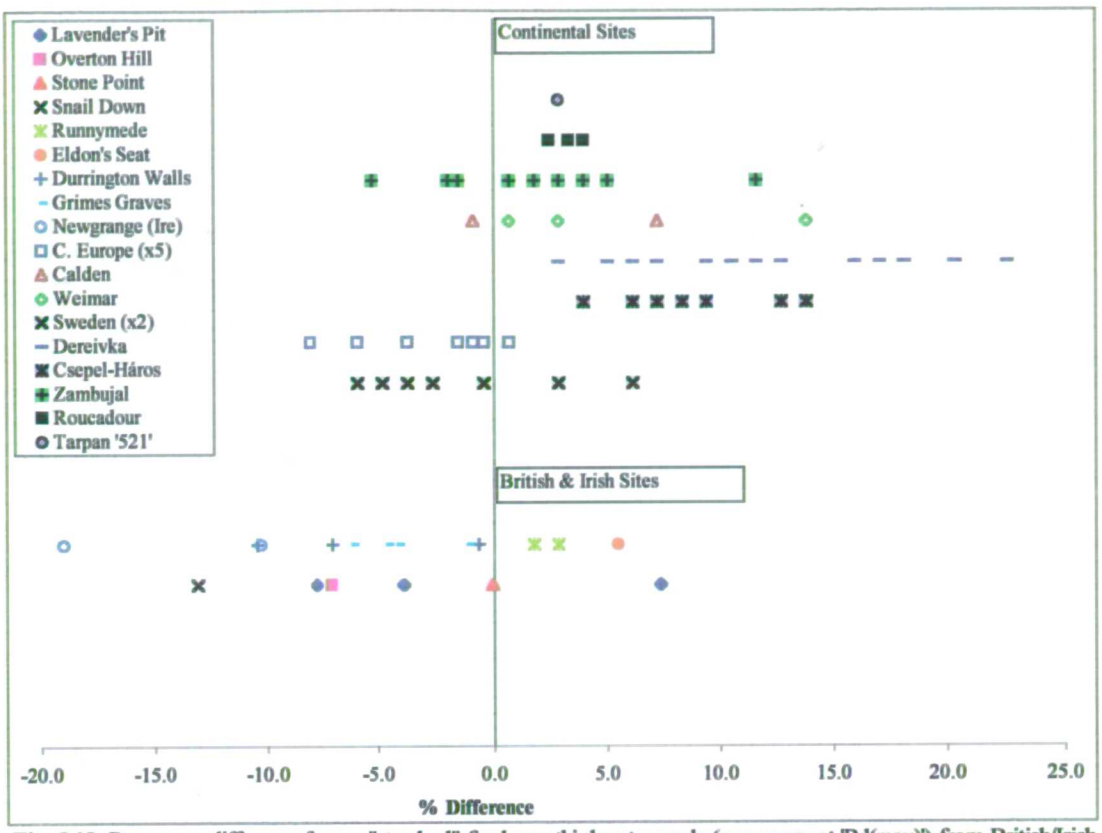

Fig. 5.19. Percentage difference from a "standard" for horse third metacarpals (measurement 'Bd(max)') from British/Irish and continental European mid-late Post Glacial sites where the zero line is the mean of a Przewalski's horse sample (n=23). Numbers in parentheses (x*) indicate number of sites sampled.

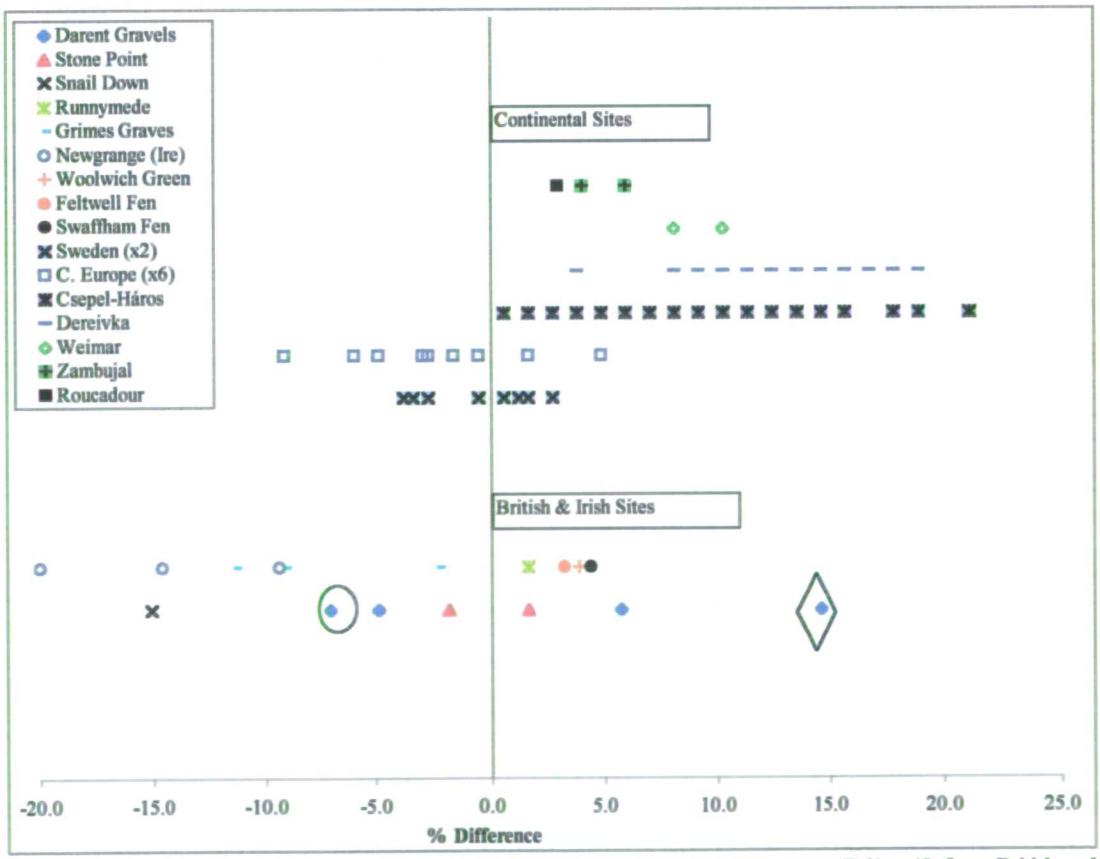

Fig. 5.20. Percentage difference from a "standard" for horse third metatarsals (measurement 'Bd(max)') from British and continental European mid-late Post Glacial sites where the zero line is the mean of a Przewalski's horse sample (n=24). Numbers in parentheses (x*) indicate number of sites sampled.

Furthermore, the supposedly Bell-Beaker aged horses from Newgrange (Ireland) lie at the smallest end of the range for all Post Glacial horses on figures 5.19 and 5.20. This indicates that these horses were very slight even in comparison to the Bronze Age and later (i.e. younger) British and continental horses. At least two theories are possible regarding the Newgrange horses: 1) They may date to an altogether different (i.e. later) interval of the Post Glacial and are small as a result of selective breeding through domestication; or 2) They are domestic horses which are smaller than the local British stock of early domesticates, suggesting that they had been imported from other regions in continental Europe. In any case, the current author's findings corroborate Wijngaarden-Bakker's (1974, 1986) findings that the Newgrange horses are "characterised by their small size and slender build"; however, no reliable evidence (in addition to that provided by their morphology) is currently available to substantiate the claim by Wijngaarden-Bakker (1974, 1986) that these animals were in fact domestic rather than wild horses. Further radiocarbon dates are desperately needed for this interesting material in order to provide support for one of these proposed scenarios; and ultimately, the key to answering these questions is a combination of criteria which includes the availability of reliably dated material as well as secure archaeological evidence of the domesticity of the animals in question.

The more easterly situated Post Glacial sites in continental Europe have yielded a wealth of horse material which, in comparison to western and central European material, is clearly larger, coming from more robust animals (figs. 5.19 and 5.20). Interestingly, rather than the French (Roucadour) or Portuguese (Zambujal) material, it is some of the German Neolithic material (e.g. Weimar, Calden) which appears to correlate well with the contemporaneous material from Dereivka (Ukraine), some of which is as large as an older (i.e. early Post Glacial) specimen from Britain (Darent Gravels: see fig. 5.20). However, there has been much debate regarding the status of the Dereivka horses, and for these purposes, the present author accepts the prevailing notion (Uerpmann, 1990; Levine, 1990) that these animals were probably wild. In fact, their large size (figs. 5.21 and 5.22), in corroboration of Uerpmann's (1990) findings, supports this theory. In contrast, the later eastern European material from Csepel-Háros (Hungary) appears somewhat smaller than that from Dereivka. Although this apparent change in body size indicates domestication, Uerpmann (1990) suggests that it unlikely that these Hungarian horses were descended from the wild population of Dereivka because they were small as well as sturdy. This discrepancy allows Uerpmann (1990)

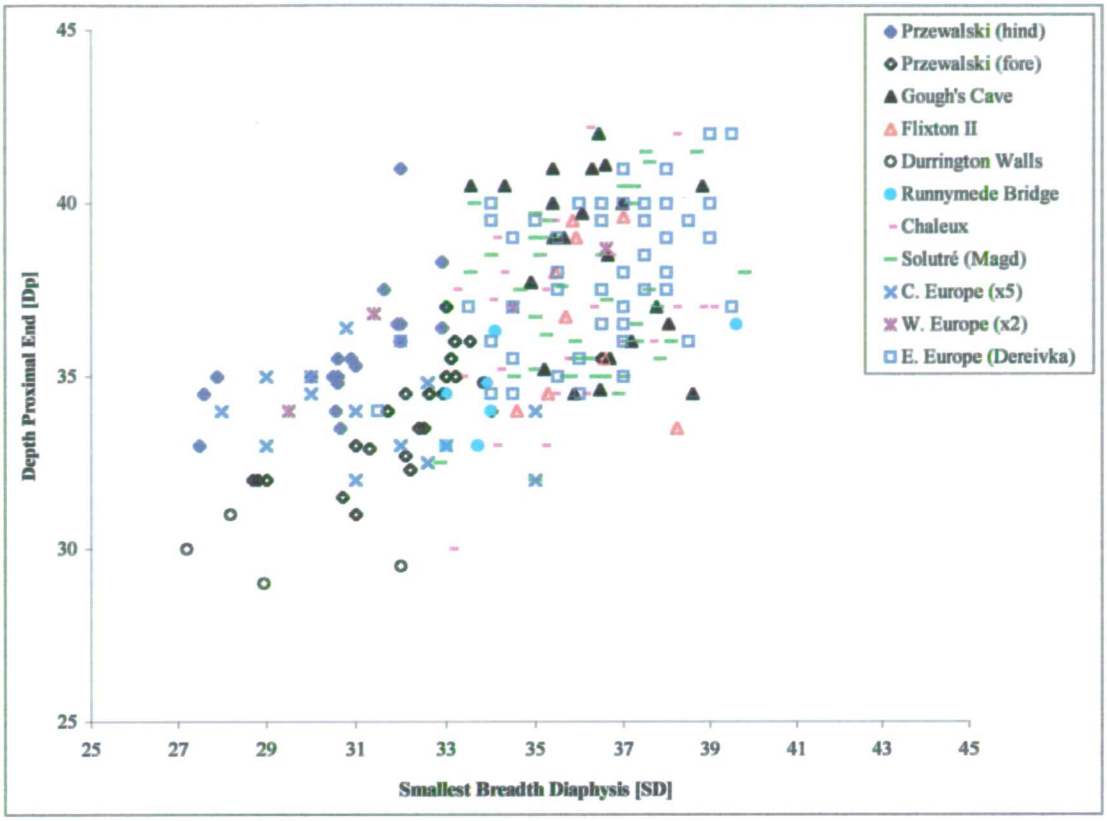

Fig. 5.21. First phalanx (fore & hind) proportions in Late Glacial and Post Glacial horses of Britain and continental Europe. A sample of Przewalski's horse phalanges has been included for comparison. Numbers in parentheses (x*) indicate number of sites sampled.

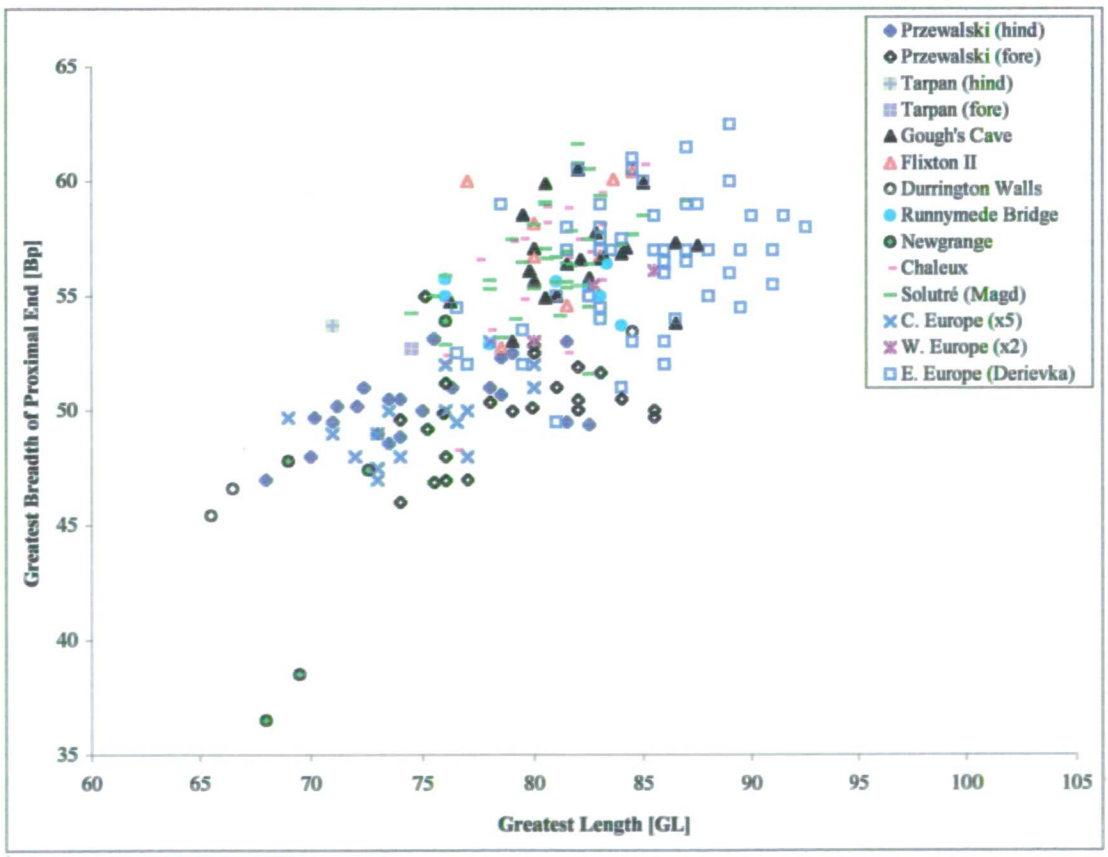

Fig. 5.22. First phalanx (fore & hind) proportions in Late Glacial and Post Glacial horses of Britain/Ireland and continental Europe. Samples of the tarpan and Przewalski's horse phalanges has been included for comparison. Numbers in parentheses (x*) indicate number of sites sampled.

to propose an eastern European wild population in addition to *Equus ferus ferus*, namely *Equus ferus scythicus* of south-east Europe and Asia Minor

In comparison to other Beaker and later material from both Britain/Ireland and western-central Europe, however, these eastern European animals are large with very robust metapodials (figs. 5.19 and 5.20). Despite their insecure status as domesticates, this evidence further suggests that a geographical or other effect may have been responsible for the morphological variation detected See section 5.4 for a further consideration of this and other issues relating to the factors affecting morphological change.

The metapodial similarities and differences between regions as well as chronological periods (i.e. Periods 1, 2 and 3) are reflected in figures 5.23-5.26. A direct comparison of material from continental (western and central Europe only) and British sites depicts a reduction in size through time; and material for each period, especially Periods 2 and 3, groups nicely when body mass is considered (figs. 5.23 and 5.24). Only a few exceptions are evident, namely specimens from the supposedly wild Neolithic horses of Germany (e.g. Weimar), whose body size approaches that for Mid-Devensian/Weichselian '*gallicus*' samples at the extreme end of the size range. In contrast, figures 5.25 and 5.26 provide evidence of variations in forms of horses via the difference in metapodial proportions of samples belonging to the different periods and regions. For example, there appears to be a consistent pattern in which the older material (Periods 1 and 2) in addition to some Period 3 material (e g from central and eastern Europe) as well as the modern 'wild' tarpan (Tarpan '521') lie along one line; while the majority of Period 3 material (e.g. from western and central) as well as the modern 'wild' Przewalski's horse sample lies along another with regard to the distal breadth measurement ('Bd[max]'). Thus, the shape difference can be interpreted as one in which Late Pleistocene/early Holocene animals have more robust and longer metapodials in comparison to later Holocene ones, many of which appear to have been shorter and more gracile. Again, it is interesting to note the large size (both in greatest length and distal breadth) of the Dereivka samples (the largest specimens for continental Period 3 on figure 5.25) as compared to the more gracile British/Irish Period 3 specimens

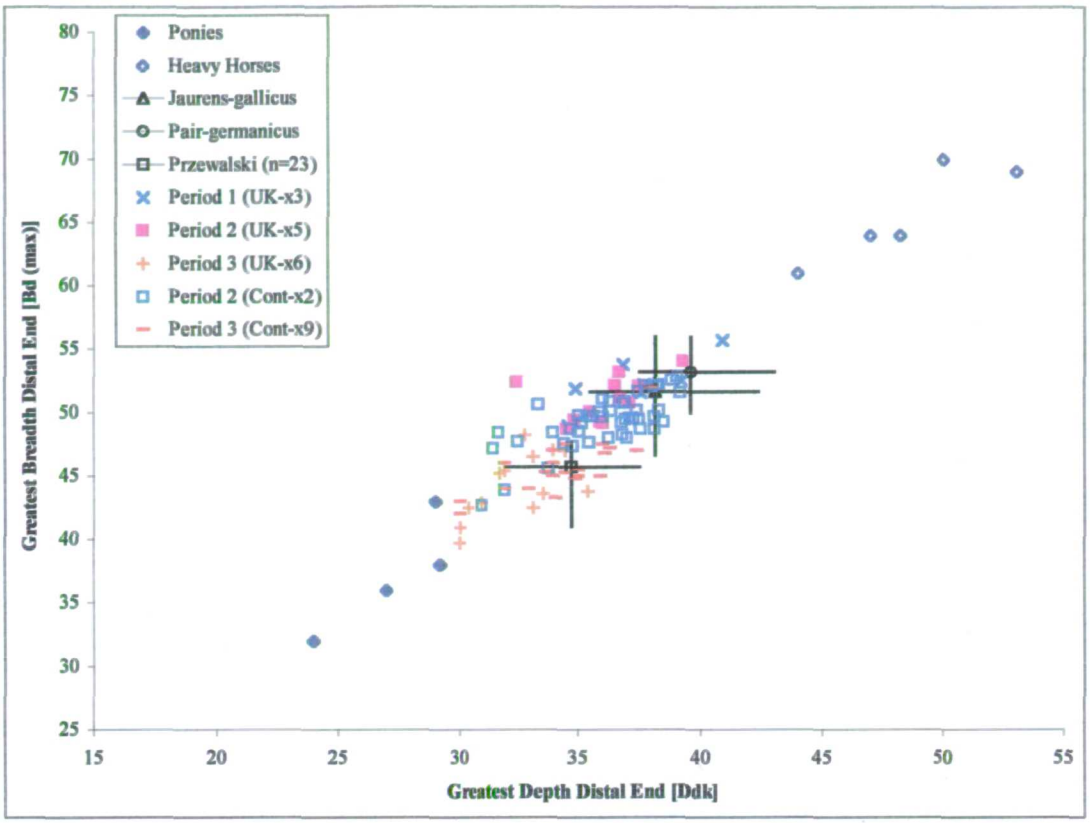

Fig. 5.23. Third metacarpal (MCIII) proportions in Late Pleistocene/Holocene horses of Britain and continental Europe. Samples of modern Przewalski's horses, ponies and heavy horses have been included for comparison. The Przewalski's (n=23) and Late Pleistocene samples from Jaurens (n=32) and Pair-non-Pair (n=24) are represented by one point (the mean) with min/max range bars. Number in parentheses (x*) indicates number of sites sampled.

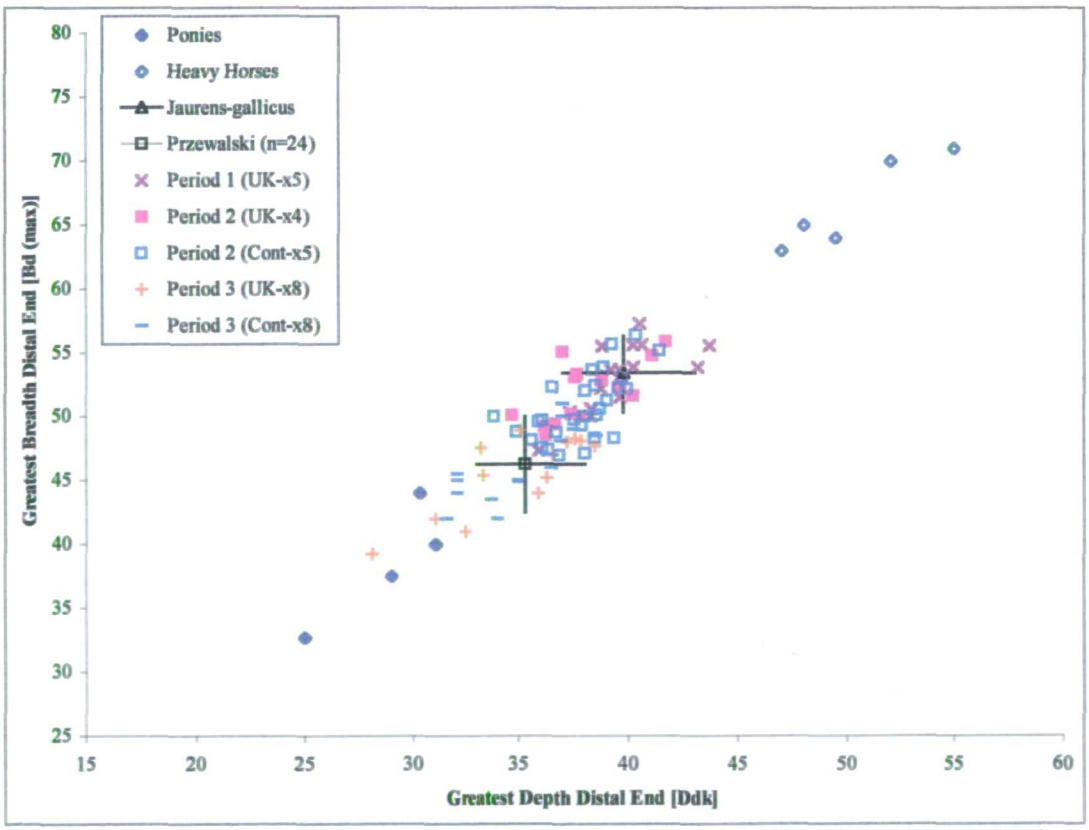

Fig. 5.24. Third metatarsal (MTIII) proportions in Late Pleistocene/Holocene horses of Britain and continental Europe. Samples of modern Przewalski's horses, ponies and heavy horses have been included for comparison. The Przewalski's (n=24) and Late Pleistocene samples from Jaurens (n=29) are represented by one point (the mean) with min/max range bars. Number in parentheses (x*) indicates number of sites sampled.

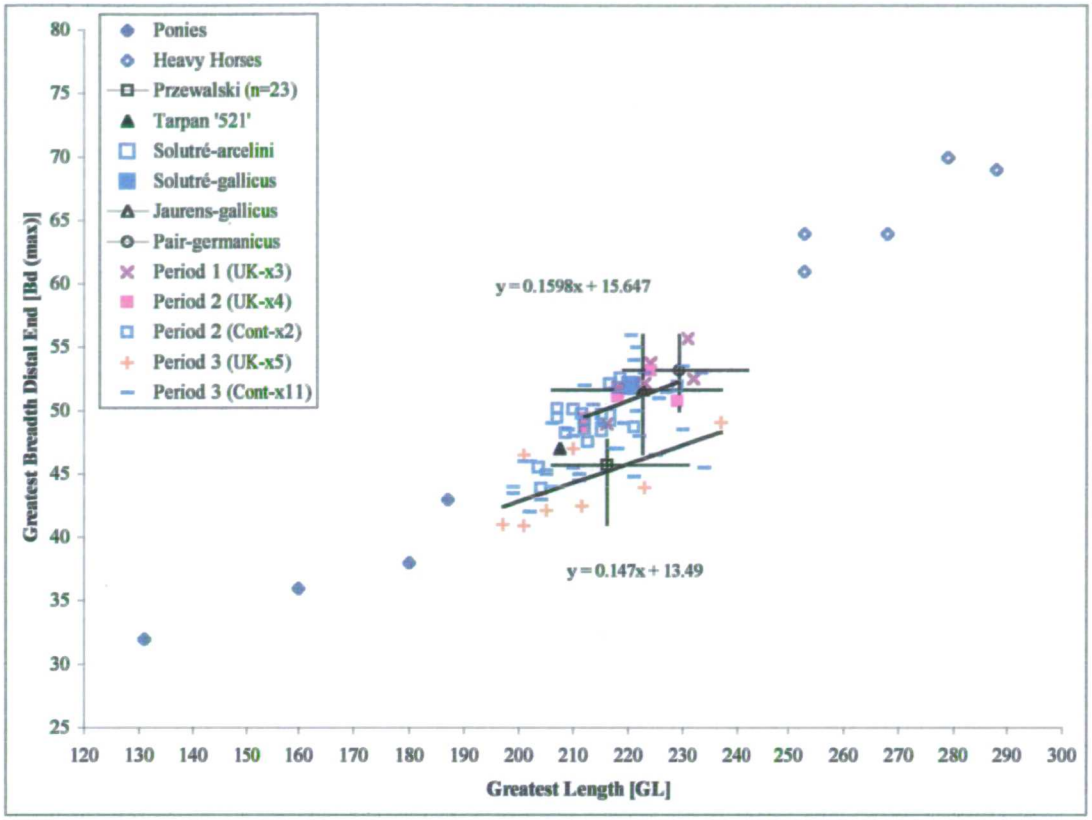

Fig. 5.25. Third metacarpal (MCIII) proportions in Late Pleistocene/Holocene horses of Britain/Ireland and continental Europe. Samples of modern Przewalski's horses, ponies and heavy horses have been included for comparison. The Przewalski's (n=23) and Late Pleistocene samples from Jaurens (n=33) and Pair-non-Pair (n=24) are represented by one point (the mean) with min/max range bars. Number in parentheses (x*) indicates number of sites sampled.

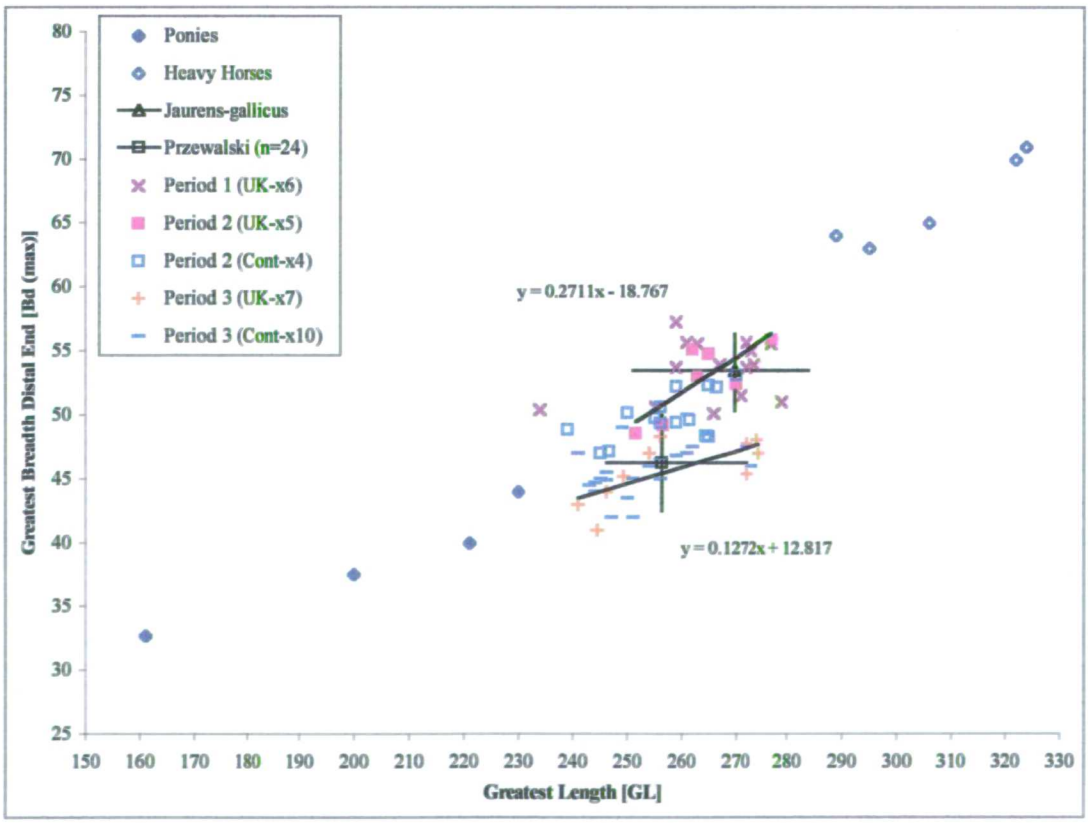

Fig. 5.26. Third metatarsal (MTIII) proportions in Late Pleistocene/Holocene horses of Britain/Ireland and continental Europe. Samples of modern Przewalski's horses, ponies and heavy horses have been included for comparison. The Przewalski's (n=24) and Late Pleistocene samples from Jaurens (n=30) are represented by one point (the mean) with min/max range bars. Number in parentheses (x*) indicates number of sites sampled.

5.4 Discussion of morphology in relation to geographic, environmental and anthropogenic factors

Although the sections above have described the morphology for a variety of horse samples from different regions (Britain/Ireland and the Continent), it is now necessary to discuss the factors which may have brought about these changes. Three key themes have been mentioned briefly and they include components of geography (e.g. west to east clines), the environment (e.g. prevailing climate and vegetation), and anthropogeny (e.g. evidence of domestication). Discrete examples of these themes will be discussed in detail below with regard to both intra- and inter-regional comparisons.

5.4.1 Geographic variation

One of the aims of this section is to investigate whether or not the data presented in section 5.3.2 for Britain and Ireland provide some evidence for intra-regional morphological variability. In Britain during the latest Late Glacial/early Post Glacial (i.e. the Younger Dryas and Pre-Boreal/Boreal), there are several instances for which comparisons can be made between more northerly and more southerly situated populations. However, figure 5.2 clearly shows that there is no consistent pattern. For example, material from southern Younger Dryas sites (e.g. Chelm's Combe, Somerset) can be compared to material from similarly dated northern sites (e.g. Flixton II, N. Yorkshire); and for first phalanges, the material from southern sites appears to be no larger than that from northern sites. Similarly, for metapodials, there appears to be no clear difference in size (i.e. for MTIII 'Bd[max]'). Therefore, this inability to find significant geographical differences forces the author to concentrate on the more notable geographic differences apparent between British and continental material.

As has been mentioned several times throughout this chapter, there appears to be a significant difference in size between British Late Glacial/early Post Glacial (i.e. Period 2) material and that of a similar age from western and central continental Europe For particular intervals of Period 2 (e g the Bølling), it is evident that British horses are significantly larger than continental ones (e g. fig 5.18) However, it is necessary to determine whether this difference in size is linked to geographical isolation or not. A key idea that needs to be reiterated at this stage is the fact that these populations were not strictly geographically separate during Period 2 (i.e. the 'Channel' was not yet evident); thus, it is not possible to attribute morphological differences to

geographical isolation alone. On the other hand, because it is known that the prevailing environments between the two regions were not exactly similar (see chapter 3), it is more likely that the environmental (i e. climatic and vegetational) differences between the two regions had more of an effect on this disparity in body size (see section 5.4.2).

Another key aspect of this debate concerns geographical variation in relation to chronology. For example, the continental sites represented in the current work (e g. figs. 5.17 and 5.18) between them have yielded horse dates which range from c. 15,000 BP (e g. Solutré) through the early to the middle Bølling (e.g Andernach and Chaleux at c. 13,000 BP and Solutré at c.12,500 BP, respectively); whereas the interval for British material only lasts c. 1,300 years BP, but it covers the whole of the Bølling (from the latest Pre-Bølling at c. 13,300 BP to late Bølling at c. 12,000 BP) rather than just the first half (see chapter 4). Therefore, it could be hypothesised that the difference in duration of these chronological intervals (i.e. c. 2,500 versus c. 1,300 years) could account for the variation detected between British and continental material if there was a chronocline toward larger size. However, the evidence of significant morphological variation presented in section 5.3.4 is considered by the author as sufficient to rule out this hypothesis.

In contrast, it appears that inter-regional geographical variation is more apparent during the Post Glacial (i.e. Period 3). From the middle Post Glacial onwards, it is clear that populations became more geographically isolated from one another due to changes in environmental conditions (e g sea level rise during the Atlantic [pollen zone VIIa], spread of woodland from the Boreal [pollen zone VI] onwards) as well as the increasing human impact (e.g. shrinkage and division of existing wild horse ranges: see Forsten, 1993) As a result, during Period 3, a geographical pattern emerges in which animal body size in eastern populations appears to be significantly larger than that of western ones For example, continental workers (e g. Nobis, 1971; Forsten, 1988, Uerpmann, 1990) determined that western/central populations of European Post Glacial horses appear to have had less robust limbs than eastern ones (e g. the Beaker site of Csepel-Háros, Hungary). Furthermore, the current work can support these findings with evidence that British/Irish Post Glacial horses appear more closely allied in body size (i e. based on gracile metapodial proportions) with contemporary western/central continental populations See sections 5.4 2 and 5 4 3 for a further discussion of the environmental and anthropogenic variables which relate to these apparent geographical differences

As an interesting aside concerning geographical variables, the author directly compared the morphology of modern wild horses (Przewalski's horse of Mongolia) with that of Late Pleistocene and Holocene horses of Europe. Limb bone data show that in body size, the Przewalski's horse is markedly smaller than the British and continental European Late Glacial/early Post Glacial population (e.g. figs. 5 17, 5.18, 5.23, 5.24). Furthermore, in detailed morphology, the standard population of Przewalski's horse shows significant differences in which their metapodials are more gracile, while their cheek teeth (premolars and molars) are larger than those of the ancient wild horses of Britain and western/central continental Europe (figs. 5.27 and 5.28). This clear difference in tooth to body size ratio is borne out in figure 5.29 which depicts samples of British and continental Late Glacial cranial and postcranial material compared to the mean of a standard Przewalski's population. The smaller body size (i.e. body weight) of these modern wild horses could simply be an ecophenotypic effect in which the environment directly affects an animal's growth (Lister, 1997); and the cheek tooth to body size ratio indicates the involvement of some genetic differentiation between eastern and western wild horse populations.

Because it is a common notion that "teeth react conservatively to changes in body size" (Uerpmann, 1990), it can be assumed that the ancestors of the Przewalski's horse had a larger body size than does the extant population. For example, Nobis (1971) pointed out that the Last Glaciation (i.e. of Mid-Weichselian age: c. 24,200 BP) horses from eastern Europe (Mezin, Russia) had relatively large teeth (figs. 5.27 and 5.28), while Forsten (1988) notes their body size as larger than those from western samples (e g. Solutré, France). Therefore, it is possible that this eastern form is closer to the ancestry of the living Mongolian wild horse (i.e. Przewalski's horse) than were its western European contemporaries. In fact, these data further suggest that this extant wild horse may be the last remnant of a west-east cline first detected by workers on the Continent (e.g Lundholm, 1947; Nobis, 1971; Forsten, 1988; Uerpmann, 1990)

5 4 2 Environmental change

It is well-known that, in wild populations of mammals, body size can be determined by particular environmental variables such as temperature and resource quality and availability (Marshall and Corruccini, 1978, Davis, 1981; Lister, 1989). For example, larger body size and/or a better animal growth period may correlate with availability of ample resources (Guthrie, 1990b); conversely, small size may be

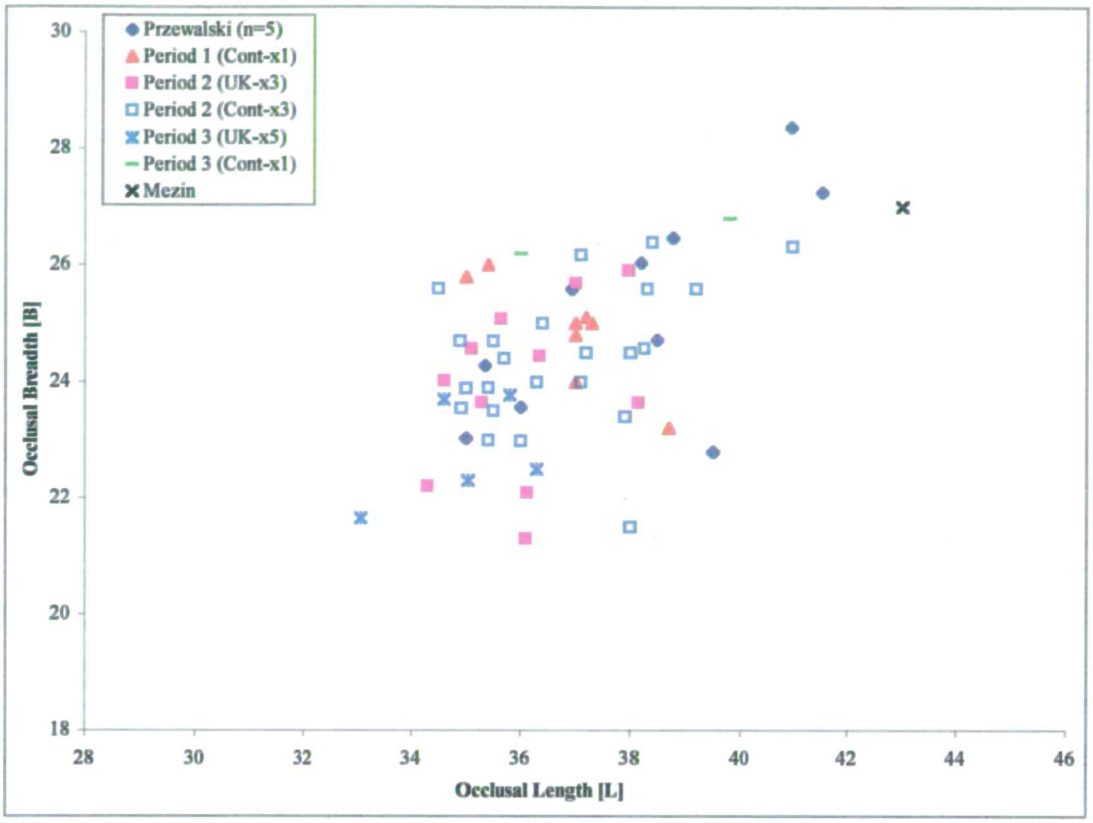

Fig. 5.27. Upper 2nd premolar (P2) proportions in Late Pleistocene/Holocene horses of Britain and continental Europe. A sample of modern Przewalski's horses (n=5) has been included for comparison. Number in parentheses (x*) indicates number of sites sampled.

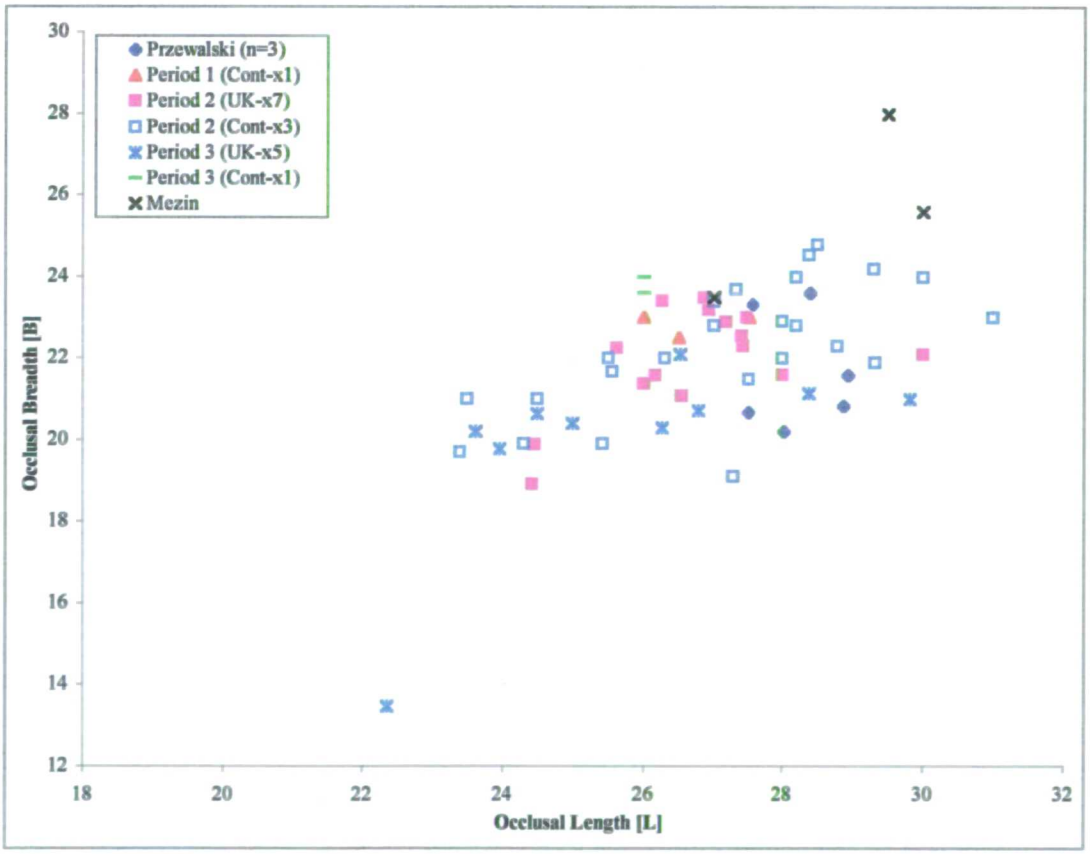

Fig. 5.28. Upper 3rd molar (M3) proportions in Late Pleistocene/Holocene horses of Britain and continental Europe. A sample of modern Przewalski's horses (n=3) has been included for comparison. Number in parentheses (x*) indicates number of sites sampled.

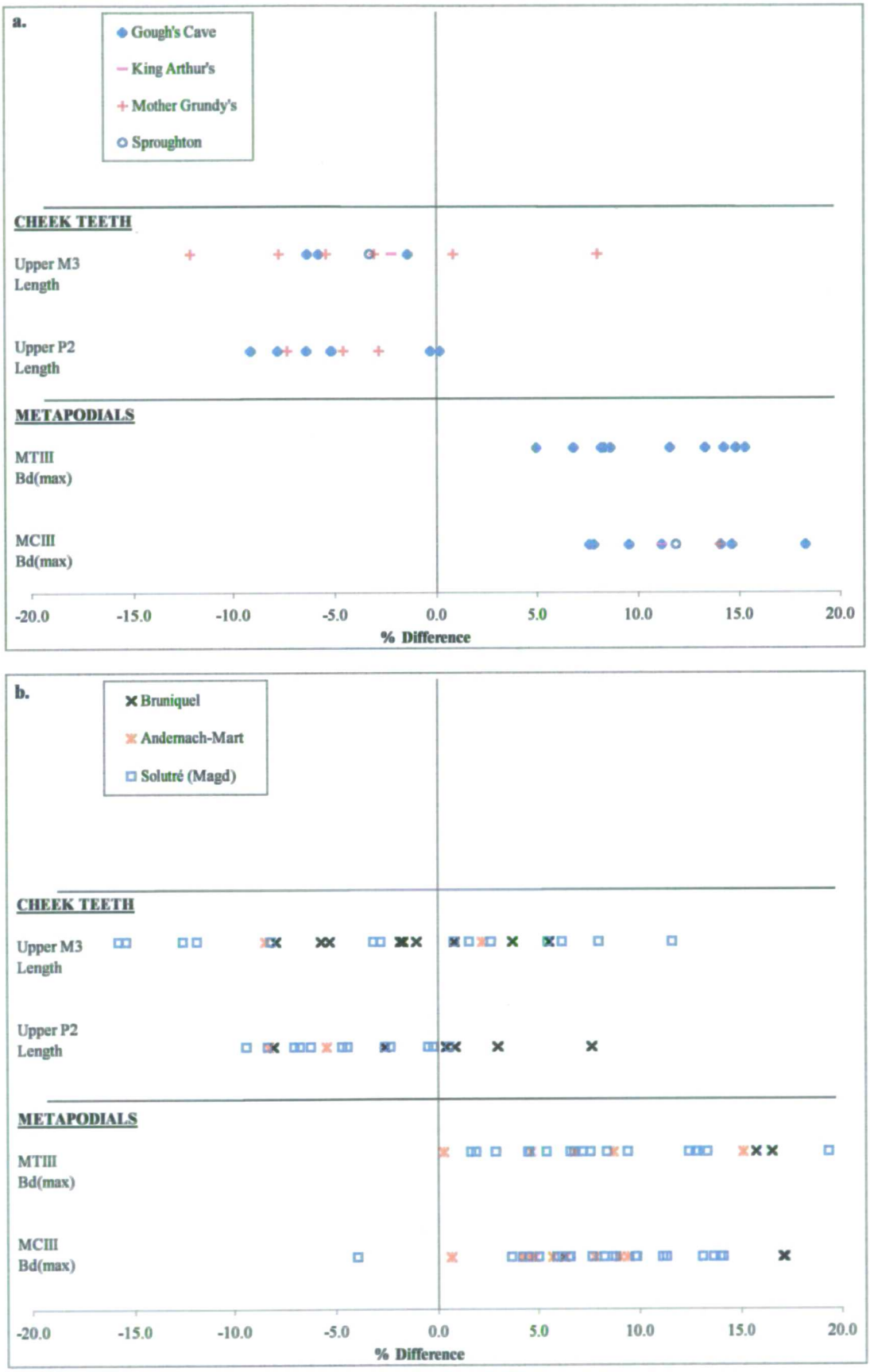

Fig. 5.29. Percentage difference from a "standard" for horse cheek teeth (measurement 'L') and metapodials (measurement 'Bd(max)') from British (a.) and continental European (b.) Late Glacial sites where the zero line is the mean of a Przewalski's horse sample (metapodials: n=24; cheek teeth: n=10).

selected for in vegetationally limiting conditions. These variables do not necessarily have as severe an impact on the size of domesticated animals; however, it is necessary to introduce them in relation to their wild ancestors before their effects on domesticates can be assessed (see below). With regard to the Late Pleistocene and Holocene wild horses of Britain and continental Europe, the progressive and gradual size decrease seen from Period 1 through to Period 3, for both regions, might indicate a correlation between horse body size (i.e. body mass) and temperature and/or vegetational abundance/quality. At this point, it must be noted that a conscious attempt was made to utilise postcranial variables (particularly metapodial and phalange breadth and depth measurements), instead of cranial ones, due to their higher positive correlation with respect to body mass for horses (Alberdi *et al.*, 1995). Furthermore, it is clear that a number of body size change 'events' are evident, and each can be compared with contemporary environmental 'events' which incorporate both climatic and vegetational changes. Therefore, the aim of this section is to determine whether the evidence for morphological variation presented above is influenced more by the prevailing climate (i.e. temperature), by vegetation or by a combination of factors.

The first 'event' concerns the gradual size decrease in which the robust '*gallicus*' form of the Mid-Devensian/Weichselian was succeeded by the smaller, more gracile '*arcelini*' form of the Late Glacial Interstadial (e.g. Windermere, Bølling), an event which coincides with a rapid amelioration of the climate as well as an increase in the abundance and quality of vegetation (see chapter 3) Because there is a size reduction rather than a size increase as might be expected by the vegetational factor, it is clear that the environmental temperature has had more of an impact on body size. Therefore, this scenario evokes Bergmann's Rule, an ecological rule which is linked to the idea that large size is adaptive in cold environments due to the fact that body surface area decreases relative to body mass thereby providing the animal with a "reduced cooling rate" (Geist, 1987; Marchand, 1996). Because there is no evidence for an unbroken sequence of Mid-Devensian to Late Glacial horses (i e a gap in presence during the Glacial Maximum: c. 20,000-15,000 BP: see chapter 4) at any particular site in Britain, migration of smaller horses from the Continent should not be ruled out However, secure evidence for a progressive size decrease is available for complete Late Pleistocene sequences at sites on the Continent (e g Aurignacian to Magdalenian at Solutré, France) which had been affected by similar (although less severe) environmental changes.

The next 'event' concerns those Late Glacial populations of animals whose body size (i.e. as expressed in terms of postcranial breadth measurements reflecting body mass) increased from the Bølling form to the Younger Dryas form. The progressive cooling which is known to have taken place towards the end of the Late Glacial interstadial through to the end of the Pleistocene appears to have been concurrent with the change in size, especially in Britain. In contrast, the continental data are at present too insufficient to be conclusive (i.e. only one Younger Dryas sample from Kartstein-Abri). The distributional and chronological data presented in chapter 4 support the idea that wild horses were prevalent before and during this cold interval. In fact, horses appear to have flourished throughout Younger Dryas Britain (from Scotland and Yorkshire in the north to Somerset and Devon in the south), despite the environment having been at its harshest (i.e. low temperatures and sparser vegetation of low quality) (see chapter 3). Again, this scenario provides another example of horses apparently responding to climatic rather than vegetational change (i.e. in both cases, environmental deterioration), which according to physiological rules should favour survival of a smaller (i.e. lighter) animal over a larger (i.e. heavier) one (Marshall and Corruccini, 1978; Forsten, 1988; Lister, 1997).

As mentioned previously, this relationship between body size with temperature evokes Bergmann's Rule: mammalian body size is inversely correlated with environmental temperature. Despite the arguments presented against Bergmann's Rule (Geist, 1987), this particular size change 'event' for European Late Glacial horses appears to support the rule. Furthermore, as an endorsement of the current work, Davis' (1981) morphological data for carnivores and herbivores provide evidence that "environmental temperature is a size determinant of large mammals".

In contrast to the so-called 'small' '*arcelini*' form of the preceding intervals (e.g. Bølling Interstadial), an even smaller horse appears to have been present during the latest interval of Period 2 in both Britain and western/central Europe. Again, the morphological evidence given in section 5.3, seems to support Bergmann's Rule for horses of the Boreal interval of the early Post Glacial (e g animals from Flixton II and Bedburg-Königshoven). It appears that as a result of another sudden and rapid amelioration of the climate at the end of the Late Pleistocene, the somewhat larger, more robust animals of previous intervals seem to have become smaller and slightly more gracile However, the causes of this apparent further decrease in size are more difficult to tease apart than in previous intervals because this size change occurred in

the face of vegetational changes (i.e. transition from steppe to woodland) which may have been severe enough, from a horse's point of view, to have profoundly affected body size. In this case, it is possible that increased grassland habitat patchiness in Britain and western/central Europe during the early Post Glacial worked in tandem (with climatic amelioration) on the morphology of wild horses. In support of this, Forsten (1988) and Guthrie (1984) both believe that a change in resource availability had affected the size of individuals in latest Pleistocene to Holocene populations, which eventually resulted in dwarfing if availability was low. Also, Forsten (1988, 1991) mentions the idea of paedomorphism as an adaptation which results in faster maturation, reproduction and generation turnover, making easier survival in demanding habitats. Furthermore, an incidental effect of the evolution of 'dwarf' forms is to maintain an adequate population density in spite of severe limitations of habitat and/or food supply so that the chances of survival through periods of perturbations are significantly increased.

Also, the question arises as to whether this smaller form of wild horse was either a phenotypic or a genotypic dwarf. Both Forsten (1988) and Lister (1995) mention that phenotypic dwarfs can be differentiated from genotypic dwarfs on the basis of the proportions of tooth and body size, phenotypic dwarfs having larger teeth and skull in proportion to the rest of the body. A note of caution, however, must be attached to this idea in relation to British and continental wild horses because sample sizes, at present, are too small to establish whether the apparent dwarfing during the transition from the later Late Glacial to the early Post Glacial is truly genotypic rather than phenotypic. This Boreal wild horse is probably the same wild form which, according to Nobis (1955), later became domesticated in other distributional areas of western and central continental Europe (e.g. France, Germany). Since there is a lack of evidence to support this scenario in Britain, it is probable that this wild form became extinct here, the domesticates only having been imported during the later intervals of Period 3 (i e. Late Neolithic/Beaker and later).

It appears clear that the evidence presented above supports a correlation between body size and environmental temperature for the horses of the Late Glacial/early Post Glacial. In fact, if the sequence is observed in its entirety, the climate/size 'wiggle' matches throughout, and not just at individual points. This endorses further the argument which favours body size change as a result of the ideas relating to Bergmann's Rule rather than those associated with nutrition.

5.4.3 Anthropogenic factors

The phenotypic changes which result when wild animals are domesticated have been discussed in detail by many authors (e g. Zeuner, 1963; Jarman and Wilkinson, 1972; Herre and Rohrs, 1973; Clutton-Brock, 1992b, Teichert, 1993). Some of the key changes which are known to have taken place with respect to Post Glacial mammals include: 1) changes and variability in body size (e g. dwarfs and giant forms); 2) reduction in cranial capacity; 3) changes in hair/coat colour, length (i.e. longer mane and tail in domestic horses) and texture; 4) neoteny (i.e. the retention of juvenile characteristics and behaviour in adults). Not all of these characteristics, however, can be detected because they do not survive as evidence within the fossil/sub-fossil record (e.g. coat length and colour, neotenous behaviours). Other changes, such as cranial capacity, are possible to detect only if skull sample sizes are sufficient, and this is not the case with continental European let alone British horses. Therefore, in the current project, the detection of change and variation in body size seem to be the only possible correlates of domestication. Of course, other variables may be present in archaeological deposits (e.g. horse trappings such as bridles and cheek pieces) which suggest that the animals recovered are domesticates. See chapter 6 for a further discussion of this topic in relation to the morphological evidence.

Body size change and variation as a result of domestication is a topic worthy of discussion because it is assumed (e.g. Davis, 1981) that these events may take place independent of the environmental (i e climate and vegetation) factors which had affected their wild ancestors. However, see below for evidence of how enforced environmental changes made by humans may have similarly affected the body size of domesticates.

Early in the history of domestic animals, it was common for size change to move toward a reduction rather than an increase in body size (Zeuner, 1963). Uerpmann (1990) mentions that the "classic indicators" of domestication with regard to the horses of western Europe include a reduction in size as well as an increase in size variability Although, in many cases, there is no secure archaeological evidence supporting domestication of wild horses at European sites, there is the morphological evidence of a key size change 'event' which took place during the Post Glacial of both Britain and continental Europe. At British sites, it is clear from many of the morphological analyses in this chapter that the British horses of Period 3 are different in size to those of preceding periods presumably because they represent domesticates imported from

the Continent (see below). In general, these horses have small teeth as well as small (i.e. gracile) postcranials in comparison to a Przewalski's standard sample (e.g. figs. 5.27, 5.30, 5.31). The available data on cheek tooth to body size ratio for British and continental (i.e. Dereivka sample) Post Glacial material, however, seems insufficiently diagnostic (fig. 5.30) to provide any additional evidence in support of the genetic differentiation proposed above for eastern versus western wild horse populations (see section 5.4.1). Despite this, a pattern is clearly evident from a combination of British and western/central European Post Glacial data in which there appears to be a significant difference in metapodial proportions between wild and supposedly domestic horses (figs. 5.6-5.9 and 5.11-5.14).

Interestingly, the changes in body size which domestication appears to have brought about (e.g. a decrease in distal metapodial breadth), seem to have been mirrored by the modern wild Przewalski's horse which show a similar difference in metapodial proportions as compared to ancient wild horses (figs. 5.25 and 5.26). A reasonable explanation for this size change within a modern wild population relates to them being considered as phenotypic dwarfs based on their cheek teeth to body size ratio (i.e. larger cheek teeth in proportion to body size: see section 5.4.1). Once these animals became marginalised within an unfavourable, and thus sub-optimal, living space in Mongolia (i.e. the arid Dzungarian Gobi: see chapter 1), they had to grapple with changes in their environment (including dietary and nutritional modifications). Because modern Przewalski's horses are derived from this marginalised population, it is not surprising that changes in body size (e.g. shortening of length and increased gracility of postcranials) have become evident. In support of this idea, Pianka (1974) and Marshall and Corruccini (1978) note that "smaller average body size" can occur in "animals living in marginal areas" and that phenotypic dwarfing can be "environmentally induced". As was mentioned above, this anatomical reduction in size probably helped these animals to adjust their physiological responses in order to survive in a harsher environment. As well as being able to mature and reproduce faster, a small animal needs less food than a larger one. Thus, it is possible that the earliest domestication of horses within Europe took place in the face of some of the same consequences (e.g. enforced climatic and dietary changes) encountered by the steadily shrinking population of Przewalski's horses in Asia. Alternatively, it can be hypothesised that early domesticates were small because a deliberate selection for animals of particular proportions was taking place. Thus, it is possible that selective

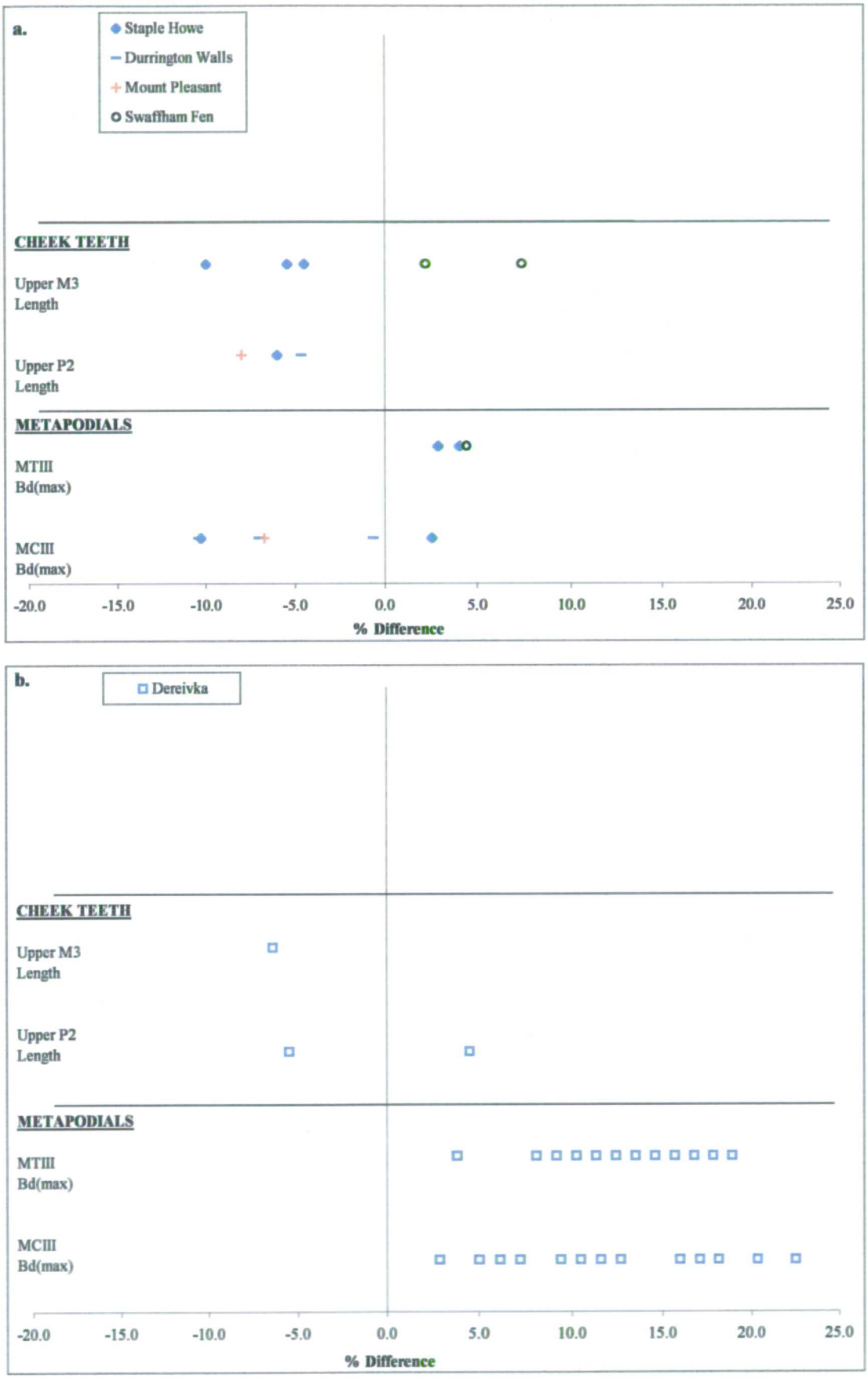

Fig. 5.30. Percentage difference from a "standard" for horse cheek teeth (measurement 'L') and metapodials (measurement 'Bd(max)') from British (a.) and continental European (b.) Post Glacial sites where the zero line is the mean of a Przewalski's horse sample (metapodials: n=24; cheek teeth: n=10).

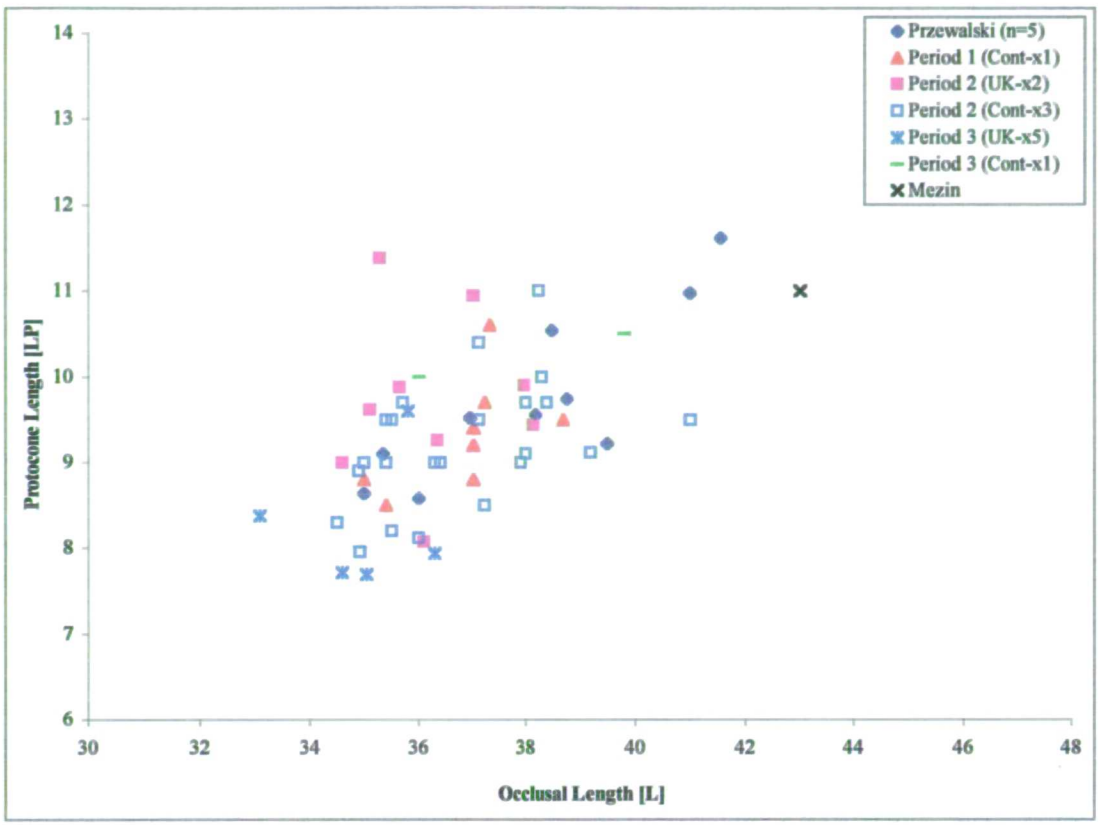

Fig. 5.31. Upper 2nd premolar (P2) proportions in Late Pleistocene/Holocene horses of Britain and continental Europe. A sample of modern Przewalski's horses (n=5) have been included for comparison. Number in parentheses (x*) indicates number of sites sampled.

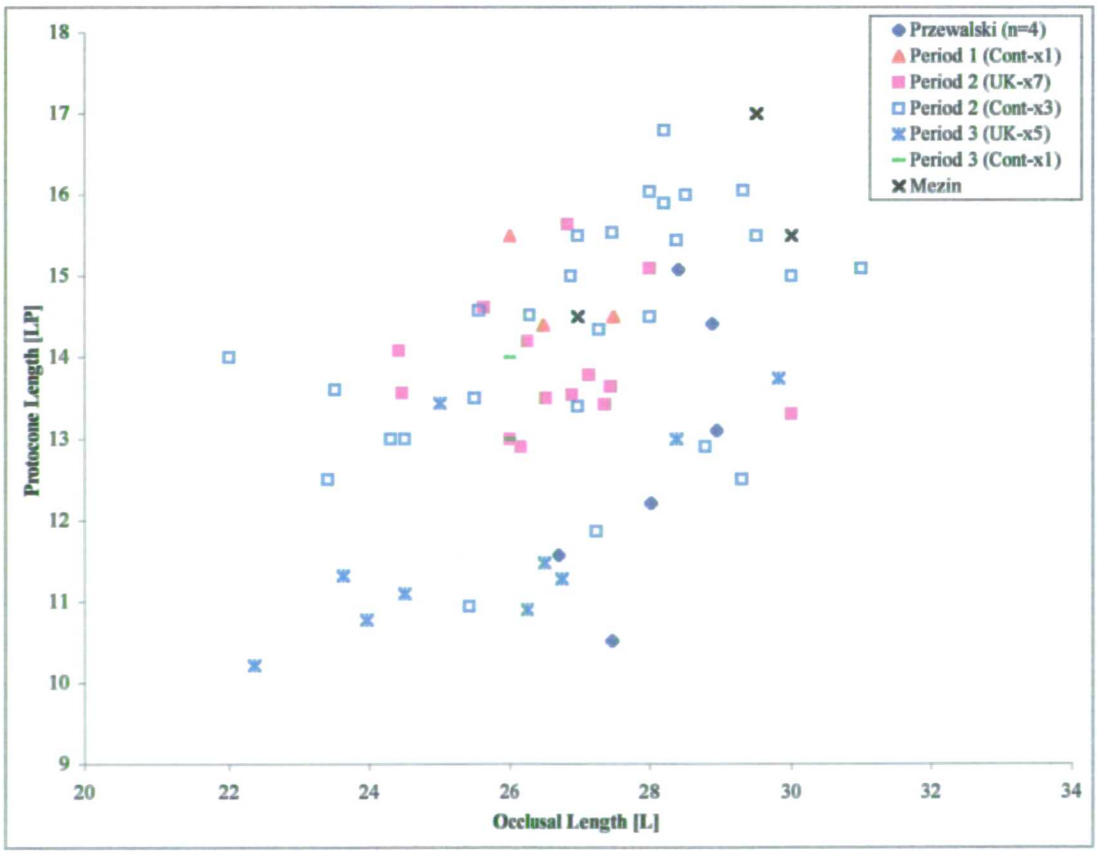

Fig. 5.32. Upper 3rd molar (M3) proportions in Late Pleistocene/Holocene horses of Britain and continental Europe. A sample of modern Przewalski's horses (n=4) have been included for comparison. Number in parentheses (x*) indicates number of sites sampled.

breeding was the cause of their small size rather than a change in 'environmental' conditions.

Although Jarman and Wilkinson (1972) suggest that the isolation and segregation of animals by humans often "mimics the effects of natural isolation (e.g. geographical, ecological, biological)", it must be noted that there are minor problems with this theory in relation to the size change seen in early domestics as compared to that exhibited by modern Przewalski's horses. If these modern wild horses are to be regarded only as phenotypic (rather than genotypic) dwarfs, then these animals should retain the "potential to regain normal size under improved conditions" (Marshall and Corruccini, 1978). However, as yet, this is impossible to test, because all extant populations of Przewalski's horses are humanly managed (i.e. managed herds living in zoos or conservation areas), and thus are not living under optimal conditions. Re-introduction programmes currently taking place in Mongolia may eventually help to shed more light on this morphological conundrum.

In addition, similarities between Przewalski's horses and early domestics can be detected with respect to cheek teeth proportions. For example, figure 5.32 shows that a Przewalski's sample is more closely allied with that of a British Post Glacial (i.e. Period 3) sample with respect to protocone length. It is possible that this is an ecologically important variable. In fact, Eisenmann (1988), Gromova (1949) and Guadelli (1987) suggest that protocone length is functionally related to the requirements of a particular environment (e.g. quality and texture of the food) A longer protocone is meant to be useful for dealing with coarser and more abrasive food as well as the inclusion of dust particles which are encountered in a particularly arid environment. However, at present, this is a hypothesis in need of further testing. Again, because enforced dietary changes due to marginalisation in a sub-optimal habitat (i.e. the arid Dzungarian Gobi) may have caused changes in the Przewalski's cheek tooth morphology, it is conceivable that a similar, drastic dietary change (i e diet and nutrition under human control) could have affected early domestic horses. Furthermore, Lundholm (1947) found that further morphological changes in the area of the cranium (e g. reduction in cranial capacity) occurred within the population of captive Przewalski's horses and that these "have the same trend as the changes resulting from domestication".

The morphological evidence given above supports the idea that the size change detected in early domestics is probably not completely independent of climatic and

vegetational factors. However, this evidence does not entirely refute the suggestions of some authors (e.g. Davis, 1981) who support independent size change as a result of domestication. Regarding domestic animals, Clutton-Brock (1992b) notes that artificial selection and reproductive isolation, as independent factors, "lead to the development of different breeds", a 'breed' being "a group of animals selected by humans to possess a uniform appearance which is inheritable and distinguishes it from other groups of animals in the same species". Thus, because the range of morphological variation appears to be so extensive with respect to British and western/central continental European Post Glacial horses (i.e. Late Bronze Age and later), the effects of early breed differentiation on size and postcranial proportions must not be ignored. It is probable that by the Late Bronze Age, genetically selected changes in phenotype were taking place among the domesticated horse populations of different regions of Europe. For the earliest times, it is probably more acceptable to embrace Jarman and Wilkinson's (1972) view that the earliest domestic animals "were exploited for the qualities they already possessed rather than with a view to including selective changes". Despite this, it is clear that as the body weight (i.e. reflected by depth and breadth dimensions) of early domestic horses changed, so did their stature as evidenced by the variation in lengths of some key postcranial elements (e.g. metapodials: see figs. 5.25 and 5.26). On the other hand, it is possible that this variability was the result of successive importations and exportations between Britain/Ireland and the 'domestication centres' within continental Europe (e g eastern Europe), rather than evidence of distinguishable regional breed types as is the current (unsubstantiated) thinking regarding breeds of domestic horses and ponies (see chapter 2).

5.4 4 Overview and Conclusions

It is clear from the above that the trend of size reduction in '*E. ferus*' through the Late Pleistocene to Holocene across continental Europe has been detected in Britain. More importantly, a series of body size stages are observed in Britain from the Mid-Devensian through to the early Post Glacial. First, body size appears to have decreased (i.e. evidence of shorter, less robust postcranial elements) from the Mid-Devensian to the Late Glacial interstadial (i.e. Bølling) It then increased (i.e. evidence of increased robustness of postcranial elements) from the Bølling to the latest interval of the Late Glacial, the Younger Dryas, and finally it appears to have decreased again through to

the early Post Glacial (i e. Boreal). In each instance, these transitions coincided with changes in environmental conditions (e.g. temperature as well as vegetational abundance/quality) However, based on the extensive morphological evidence presented above, a correlation of body size with temperature (following Bergmann's Rule) seems more probable than with nutrition (e g. during the Younger Dryas, larger body size coincides with a decrease in temperature as well as a reduction in vegetational abundance for ungulates). Furthermore, although it appears that similar patterns are evident regarding contemporary continental European horse material, sample sizes for particular intervals of the Late Glacial (e.g. Younger Dryas) are, as yet, too insufficient for firm conclusions to be made.

A further size change (i.e. a reduction) and evidence of morphological diversity is detected for British horses during Period 3 (i.e. middle Post Glacial and later) as well as for contemporaneous samples from the Continent. This change in size and proportions is evidence which possibly signals the appearance of the earliest domesticates in Britain and continental Europe. The presence of these domestic animals at particular sites was either as a result of local domestication (in the case of continental Europe only) or importation from the elsewhere on the Continent (e.g. more easterly situated sites) (Uerpmann, 1990). Despite this fact, it seems likely that Britain and Ireland are two of the last places in Europe to provide evidence for domesticated horses. In contrast, continental sites (e.g. in Germany) appear to provide a more complete Post Glacial chronological sequence with regard to the transition from wild to domestic, especially from the Neolithic onwards (Uerpmann, 1990).

With regard to the modern wild Przewalski's horse, it must be noted that despite its phenotypic similarity to prehistoric representations of European Weichselian horses (i.e. in Palaeolithic art: see chapter 2, section 2.3), it differs from the latter in both skeletal and dental proportions, and is smaller in body size (see above). This body size difference can be qualified further by comparing estimates of body weight with those of withers height (see section 5.2 2) For example, figure 5.33 shows that a modern Przewalski's horse sample differs significantly (see table 5.15) in body weight from individual and combined samples of Period 2 horses (British and continental). However, it is interesting that, with respect to withers height (fig 5.34), the two samples do not differ significantly (see table 5 16). Therefore, the body shape of the modern Przewalski's horse appears to be that of a 'lighter' animal, but of similar stature, in comparison to fossil wild horses of the Late Glacial/early Post Glacial of Europe.

Table 5.15. T-testing data (2-tailed, 2-sample unequal variance) for Body Weight of Przewalski's Horses and Late Glacial/Early Post Glacial Horses of Britain and Continental Europe

Body Weight
Przewalski's horse (n=21) vs. UK Late Glacial/Early Post Glacial (n 9)
p= 0.0062
Przewalski's horse (n=21) vs. Continental Europe Late Glacial/Early Post Glacial (n=27)
p= 0.0003
Przewalski's horse (n=21) vs. UK & Continental Europe Late Glacial/Early Post Glacial combined (n=36)
p= 0.0001

Table 5.16. T-testing data (2-tailed, 2-sample unequal variance) for Withers Height (WH) of Przewalski's Horses and Late Glacial/Early Post Glacial Horses of Britain and Continental Europe

Withers Height
Przewalski's horse (n=21) vs. UK Late Glacial/Early Post Glacial (n=9)
p= 0 1497
Przewalski's horse (n=21) vs. Continental Europe Late Glacial/Early Post Glacial (n=27)
p= 0.7031
Przewalski's horse (n=21) vs. UK & Continental Europe Late Glacial/Early Post Glacial combined (n=36)
p– 0.7540

Consequently, this suggests that the extant Przewalski's horse is not an unchanged relic of populations of European Late Pleistocene horses. Instead, it probably represents an eastern relic of a former continuous western to eastern cline (i.e. smaller to larger body size) of Late Glacial Eurasian horses (Nobis, 1971: based on Eurasian fossil material), and has probably only experienced phenotypic dwarfing in recent times.

Furthermore, it is necessary to briefly mention how the morphology of the modern Przewalski's horse compares to that of the tarpan or eastern European 'wild' horse Although the status of the tarpan (i e as a wild or feral domestic horse) is still unclear (see chapter 2. section 2 2 2), it is interesting to note that, in third metacarpal shape (breadth versus length), this specimen lies along a Late Glacial line (e g. 'y = 0.1598x + 15 647' for UK Period 2[x4]) rather than one (e g 'y = 0.147x + 13 49' for UK Period 3[x5]) for Post Glacial as well as Przewalski's horse material (see fig. 5.25).

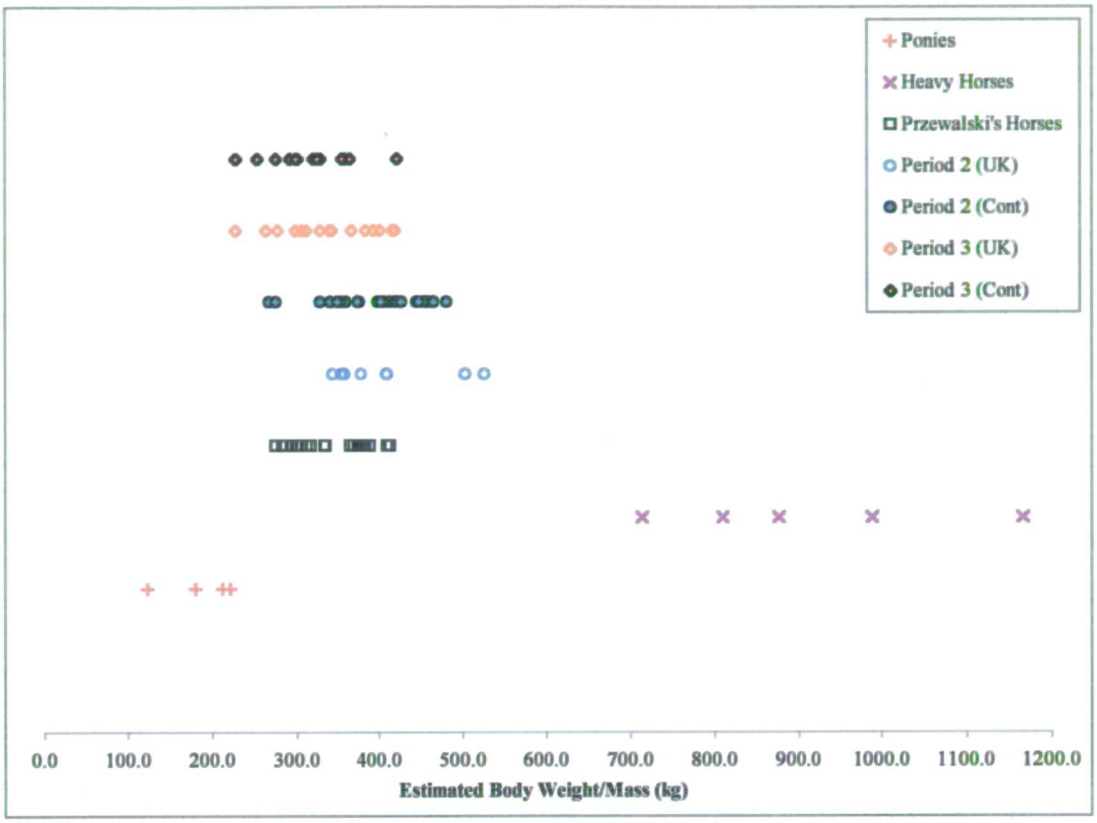

Fig. 5.33. Estimated body weights (Alberdi *et al*. (1995) method) for modern Przewalski's horses and horses from Late Glacial and Post Glacial sites in Britain and western/central continental Europe. Samples of modern ponies and heavy horses have been included for comparison.

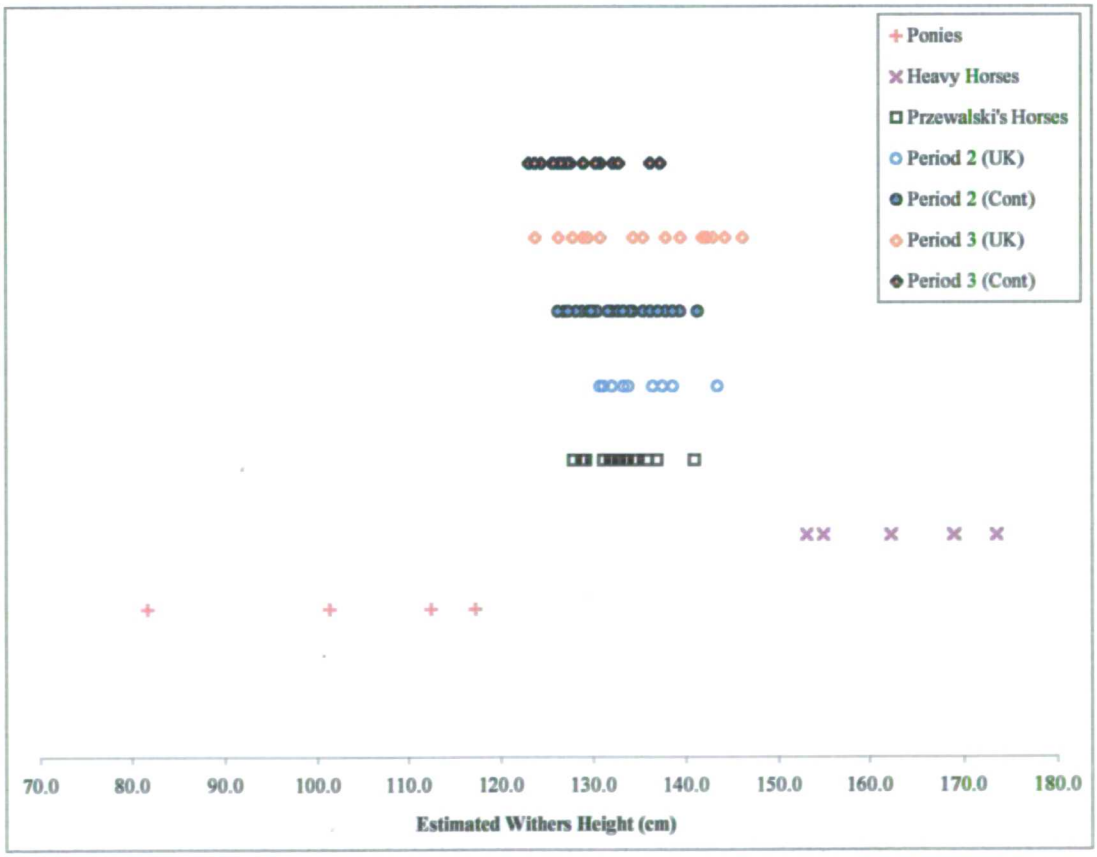

Fig. 5.34. Estimated withers heights (Kiesewalter (1888) method) for modern Przewalski's horses and horses from Late Glacial and Post Glacial sites in Britain and western/central continental Europe. Samples of modern ponies and heavy horses have been included for comparison.

In other words, the tarpan appears to be more similar to the western/central European group of wild horses based on its metapodial proportions (i.e. robust rather than gracile). However, a note of caution must be attached to this interpretation because it is based on a very small sample size for the tarpan (i.e. n=1: the last true tarpan, an eight year old gelding). Also, this morphological evidence is not necessarily of phylogenetic significance.

Overall, the data presented in section 5.4 have demonstrated that many factors may influence body size. During the Late Pleistocene and early Holocene, environmental variables, rather than mere geographical separation, appear to have had more of an impact on morphological variability; however, the body size of middle and later Holocene animals appears to have been influenced by a combination of geographic, environmental, and anthropogenic factors. Accordingly, this emphasises the complexity of the relationship between animal body size and particular variables, whether the animals be wild or domestic. Nevertheless, it must be stated that very few palaeontological examples to date (Lister, 1992) can provide this kind of detail in which the causes of body size changes can be pinpointed.

Chapter Six Discussion and Conclusions

6.1 Introduction

Until now, the horse was one of the few members of the European Late Pleistocene and Holocene fauna which had yet to be fully studied. In the present project, the author has chosen to track and magnify on a fine timescale this particular animal's response to Pleistocene and Holocene environmental changes. The wealth of evidence presented here serves to prove that profiling a single species, especially one of rather well-known ecology and environmental preferences like the horse, can be a valuable aspect of Quaternary studies. For example, this study has done much to highlight the morphological, adaptive, behavioural and habitat components of ancient as well as modern horses. Furthermore, the results detailed in the preceding chapters underscore the necessity of using a multidisciplinary approach, which employs a combination of approaches (e.g. chronological, environmental) both in reviewing previous work, and in incorporating original evidence (e.g. morphological, chronological) which results from the current study.

This section aims to highlight some of the key issues of the investigation and to explore the conclusions which can be drawn. Regarding Late Pleistocene and Holocene horses of Britain (and continental Europe), there are three primary issues on which many of the conclusions hinge:

1) Distribution, Chronology and (Palaeo)environment
   - Where and when did horses live and in what types of environments?
   - Were their chronological and geographical distributions continuous?
2) Morphology
   - What size and shape were these horses (i.e. what was their appearance like?)
   - Did their body size vary through time and space?
3) Taxonomy and relationships
   - What are their taxonomic relationships to other ancient (i.e. fossil/sub-fossil) as well as modern horses in Britain and on the Continent?

- Can development from wild to domestic horses be traced through a survey of wild predecessors?

In addition, two particular subsidiary issues regarding relationships and status need to be emphasised:

1) Alternative ways of revealing relationships with other ancient and modern horses
   - Can molecular evidence aid in the investigation of taxonomy and relationships?
   - Does molecular evidence regarding relationships support morphological data and vice versa?
2) The 'role' of the horse during particular chronological intervals
   - What was the evidence of their status as wild or domestic animals?
   - What were their relationships/interactions with humans?

6.2 Distribution, chronology and palaeoenvironment

The author's examination of horse material has resulted in an exhaustive survey of British Late Pleistocene and Holocene sites and finds (see chapter 4: gazetteer of sites). The current study is the most wide-ranging to date, having incorporated British, Irish and continental European data (published and new). Three 'pools' of evidence were used jointly (i.e. radiocarbon dating, geography and environment) in order to make a strong case for the presence (or absence) of horses at particular places and during key periods, particularly the Late Glacial to the middle Post Glacial In addition, causal factors which could have brought about continuity or breaks in chronological and/or geographical distribution were suggested.

6.2.1 Chronological and geographical distribution: continuity and discontinuity

By actively dating a single species which occurred at sites through a variety of regions and during specified periods of time, the author has assembled a 'chronological species profile' consisting of compiled datelists (including both new and pre-existing dates) for the horses of Britain/Ireland and western/central continental Europe. The present radiocarbon dating project yielded a total of 45 new, reliable dates from 31 British/Irish sites This extends the present datelist for horse in Britain/Ireland to a total of 116 reliable dates from 64 sites for the three key periods. In the course of this chronological profile of the horse, two key methods for compiling a complete and

unbiased record have become apparent: 1) provide direct dates on specimens, as well as a sufficient number of dates from a range of sites per region; and 2) attempt multiple dating (i.e. two or more dates) at each site

Once the profiles had been scrutinised thoroughly, the patterns of chronological and geographical continuity and discontinuity from Pleistocene to Holocene could be distinguished. It was also necessary to plot the geographical distribution of horses in relation to chronology in order to uncover any regional bias during particular periods, the key results of which are summarised below.

The study began with the horses of the Middle Devensian. There then appeared to be a noticeable gap during the 'Glacial Maximum' interval which included the cold Dimlington stadial c. 22,000-15,000 BP. It is probable that immigrants from the Continent repopulated Britain at the subsequent transition to the Late Glacial Interstadial. However, an alternative postulate sees these populations, together with ones which possibly survived this environmentally harsh phase in Britain, constituting the latest Pleistocene stock. At this stage of the investigation, the gap found in distribution amounts to negative evidence; and in order for either of these theories to be substantiated in the future, concrete, positive evidence is needed. Unfortunately, this has been beyond the scope of the current project, but see below (section 6.7) for research opportunities.

In any case, a substantial amount of positive evidence supports an almost continuous presence for horses in Britain throughout the Late Glacial to early Post Glacial (c. 13,400-9,100 BP) as well as the middle Holocene to Recent (c. 3,900 BP to present). Moreover, while pinpointing particular British Late Glacial/early Post Glacial sites and finds, it became obvious that horse distribution during this period covered a large geographical area in Britain alone. Interestingly, most sites with horse dated to c. 12,000-11,500 BP (early Allerød) were found to be situated in north of the country. This regional bias possibly signalled the persistence from the open Bølling of environmentally suitable habitats (i e. less woodland and more grassland) for horses in the north, in contrast to more southerly regions which were known to be afforested at this time (see chapter 3) However, by the Younger Dryas (c 11,000-10,000 BP), no geographical bias was evident Interestingly, this late interval of the Late Glacial appeared to contain an abundance of evidence for contemporaneous populations in northern (e g. Lothian, North Yorkshire) as well as southern (e g Somerset) regions, proving that geographical distribution was widespread

It has been necessary to highlight the significant gaps (i e. absence of horses) in the Late Glacial to Post Glacial chronological record, and the direct radiocarbon dating programme of the current study has served to test their authenticity. As a result, at least two significant 'breaks' in continuity have been identified and can be substantiated via datelists (see chapter 4). The earliest one, although short in duration, took place during the later Allerød (c.11,500-11,200 BP), a period in which climatic oscillations are known to have taken place (see below). The other, later (and much longer) break in presence occurred at c. 9,000-4,000 BP. The existence of a 'true' gap in continuity can be upheld by evidence which includes an abundance of middle Post Glacial sites lacking horse in their Mesolithic/Neolithic assemblages. Even at sites yielding horse remains from key deposits, the finds have proved not to date to this period (i.e. evidence of unsound stratigraphy). As a result, the author disputes the so-called Mesolithic/Neolithic contexts for horses at middle Post Glacial sites, and sees much of the confusion which has arisen as being due to provenance problems. The dating evidence here points to an absence of horses during much of the Neolithic, rather than to a certain presence as Grigson (1966, 1978) has asserted previously.

Comparisons with continental records have proved important in the interpretation of distributional continuity in Britain. It is significant that the records for each region display continuity through much of the Late Glacial (c. 13,000-10,000 BP). However, Britain now has a more definitive chronology for this late period of the Pleistocene (i.e. 63 dates from 27 British sites compared to 49 dates from 27 sites spread over eight countries).

As occurrence declined at the transition from Late Glacial to early Post Glacial in Britain, a similar pattern was detected throughout a wide area of western and central Europe. In both regions, the chronological discontinuity which followed is demonstrated by major gaps in the early to middle Holocene records (from c. 9,000-4,000 BP in Britain; from c. 9,600-7,500 BP in western/central Europe). However, there is a key difference in the chronological records of Britain and the Continent. Horses appear to have been absent in Britain throughout the entirety of the 5,000 years from c. 9,000 until c. 4,000 BP. In contrast, chronological evidence suggests that horse absence on the Continent lasted about 2,000 years with horse presence being reinstated much earlier (e g at c 7,100 BP in Spain)

Thus, both regions apparently retain gaps in their respective chronological records during an interval of the early Post Glacial which spans the Later Boreal

woodland phase (c. 9,000-7,500 BP), but this requires discussion in view of the somewhat ambiguous continental record. Horse presence is not evident during this interval in Britain, and only sparse data is available for the Continent. Uerpmann (1990) even acknowledges the rarity of finds in the Mesolithic and Early/Middle Neolithic for western and central Europe (e g. France, Germany); and as a result, finds it difficult to directly verify continuity from the Late Pleistocene through to the Early Neolithic. Although he does suggest particular reasons (e.g. stratigraphic unreliability, poor preservation, sites in inhospitable areas) for this lack of horse remains, the present author is forced to remain cautious without reliable, positive evidence. Also, continental radiometric evidence appears to shed doubt on the existence of this early Holocene material. Uerpmann (1990) provides an example from Germany (Kaster) in which the horse remains, although stratified within a Middle Neolithic deposit, actually date to the Younger Dryas c. 10,400 BP. Interestingly, this outcome was common in the course of the current radiocarbon dating project for Britain, so it is necessary to proceed with caution regarding interpretations involving supposedly well-stratified horse material for the early to middle Post Glacial. Consequently, the current author is unable to embrace assumptions of continuity based on the isolated finds of horse which remain undated (e.g. the supposedly Mesolithic wild horses of central Portugal: see Uerpmann (1990)).

6.2.2 Influence of vegetation/climate change on distribution through space and time

The evidence at hand suggests that palaeoenvironmental factors (e g. climate, flora, fauna) had an influence on horse distribution in Britain during the Late Pleistocene and the Late Glacial in particular. The strength of climatic changes in Britain in comparison to other parts of Europe (see chapter 3) as well as the existence of acute changes in vegetational patterns provide the causal factors for the apparent gaps in presence (e g. Pre-Bølling of Britain). One example identified in the current study involves a change in the distributional profile for horses during the Late Glacial Interstadial. The gap in the horse chronological record at c. 11,500-11,200 BP correlates with the peak of the main forest expansion which was characterised by a lack of suitable habitats for horses, especially during the middle to later Allerød. Later in the Late Glacial (c 11,200-10,000 BP), however, another change in environmental conditions occurred which was found to influence distribution more positively. It is conceivable that horses returned at the transition from Allerød to Younger Dryas as a

result of the opening up of previously wooded environments throughout Britain, particularly towards the south.

By the early Post Glacial, horse distribution both in Britain and western/central continental Europe was becoming more sparse leading to the major gap in the record which has been identified in the current work (see above). It is significant that this gap spans the Later Boreal woodland phase (c. 9,000-7,500 BP) as well as later intervals characterised by their warm climate and woodland vegetation. The fact that these intervals comprise the latter stages of the Atlantic (c. 6,000-5,000 BP: a period in which Britain became isolated from the Continent) had consequences for the British wild horse population. By this time, the horse population was extinct with no hope of re-instatement by means of immigration from the Continent. Conversely, the early-middle Post Glacial wild horses of continental Europe are suggested to have existed in small numbers in the forest-covered areas of western/central areas, while larger numbers were supposedly present in the eastern and south-eastern steppe regions (Uerpmann, 1990). Although this scenario is conceivable, it is nonetheless one without sufficient supporting evidence. In order to verify continuity from the Late Glacial through the early and into the middle Post Glacial, the data must include reliably-dated material of stratigraphically sound provenance.

6.2.3 Final thoughts

Although the current distributional profile for horses proves that they achieved a greater chronological continuity than any other large mammal species (e g. elk, reindeer, aurochs, mammoth) during the Late Glacial interval in Britain, the theory of extinction in the early Post Glacial followed by reintroduction during the later middle Post Glacial is upheld. Accordingly, a direct transition from wild to domestic horses was not detected in Britain during the Post Glacial, and in all probability domestic stock had been imported from other regions of Europe. The evidence given here indicates that presence was restored as a result of importations during the Late Neolithic/Beaker period.

In contrast to the scenario in Britain, the entire Late Pleistocene/Holocene profile for the Continent appears to be less definitive, particularly during the later Late Glacial and early Post Glacial. In addition, the present author is concerned that too many assumptions are currently being made without the reliable evidence for proof of continuity from the Pre-Boreal onward. Key material is either missing altogether or is

in need of verification with reliable radiocarbon dates. The fact that Uerpmann (1990) was only able to provide a few early Holocene examples (or in many cases, none: e g. Pre-Boreal to Later Boreal horses of France, Germany, Portugal) makes their existence within this period even more doubtful.

As a result of these problems, a pertinent question arises: if a 'true' gap (c. 9,000-7,000 BP = Mesolithic) existed following the end of the Pleistocene, from where was the Neolithic wild stock coming? One possibility involves Uerpmann's (1990) identification of a probable area of transition to the east of his western European form's ("*E. f. sylvestris*") range in the early Holocene (i.e. populations not geographically separated from his "*E. f. ferus*" of eastern Europe). This supports the suggestion that horses moved from east to west during the latter half of the early Holocene on the Continent.

It is now also clear that horse chronological and geographical distribution was dependent on environmental factors, the key variables being the prevailing climate as well as vegetational change. British and continental wild horses of the Late Glacial/early Post Glacial may have been most susceptible to the effects of climatic amelioration (i.e. warming) as well as encroachment of woodland during such periods as the Allerød and Boreal. Furthermore, the combined effect of rapid climatic warming and increased forestation during the early Holocene (i.e. the Boreal) created an insuperable environmental obstacle, leading to their extinction in north-west Europe after c. 9,000 BP. Extinction within Britain during the Boreal may also have been due to additional factors which included the lack of sufficient 'space' due to human use of available habitats as well as isolation from the Continent.

6.3 Morphology

In the current work, the term morphology encompasses the shape, 'type', form, and overall horse body size, where body size is defined as expressing two particular variables: stature (i e. withers height) and body weight or mass. The main aim of the morphological study has been to investigate cranial and postcranial proportions and to make body size comparisons between ancient/modern individuals and populations. In addition, body size and shape comparisons have been measured against that of a standard population (Przewalski's horses). Furthermore, it has been necessary to highlight the factors such as chronology, climate/vegetation, and human impact which

have been found to influence morphology. Subsequently, the causes of body size changes could be detailed using a multidisciplinary approach.

6.3 1 Body size: a generalised view

In the current study, standardised specimen measurements have been used to determine and describe body size, where it is accepted that a higher positive correlation exists between body mass and postcranial variables rather than cranial ones. Also, the plasticity of bones in relation to teeth/cranials has become apparent. This is in accord with the theory that teeth react less 'plastically' and respond more slowly to environmental changes compared to postcranials (Bökönyi, 1974; Uerpmann, 1990). Upon examination of modern and ancient wild horse specimens in this study, a Przewalski's horse sample was found to exhibit a larger tooth to body size ratio compared to Late Glacial wild horses, possibly as a consequence of phenotypic dwarfing This highlights the need to examine the whole skeleton and not just postcranials (or teeth) on their own in order to get the clearest picture regarding morphological variation as well as causal factors. Although the author acknowledges that this technique is often not practicable without sufficient samples at particular sites, one should still be mindful of the range of available methods before making deductions concerning body size.

Another body size issue relates to semantic matters. Because descriptions of north-west European Late Glacial horse body size are often vague, with no qualification as to which element of a whole animal is 'small' (e.g. Davis, 1981; Forsten, 1988 regarding end Pleistocene 'dwarfing' and domestication effects), one key requirement here has been to qualify what is meant by a smaller/larger body size or a reduction/increase in body size. In this study, it has been possible to 'flesh out' the bones of both ancient and modern animals using measurements to estimate overall body size, thus giving a truer indication of an individual's proportions. This has rendered descriptive statements regarding animal body size more constructive as well as more valid.

The various methods of interpreting individual measurements have also been scrutinised, and it is clear that utilising only one method to investigate morphology has severe drawbacks. For example, Uerpmann's (1990) sole use of the logarithmic size index [LSI] in investigating the morphology of European Post Glacial wild horses makes it difficult to detect the variation between individual specimens (i e. individual

animals). Therefore, the current author concludes that it is necessary to utilise a variety of methods (e.g. percentage difference, bivariate plots) in order to reflect different types of variation which may be concealed with the use of only one. This method proved successful in the current study and has provided a wealth of data which are summarised below (see sections 6.3.2, 6.3.3 and 6.3.4).

6.3.2 Body size in relation to chronology

Progressive body size reduction was found to occur in British horses from the Mid-Devensian through to the early Post Glacial. More importantly, this development was exposed as a reduction in overall body size (withers height and body weight). This is not an unusual occurrence as size reductions have been revealed for other fossil mammals at the Pleistocene/Holocene boundary (i.e. end of the Pleistocene to early Holocene) (Davis, 1981: e.g. wolf, fox, wild boar, gazelle, goat, aurochs); (Kurtén, 1968: e.g. brown bear, spotted hyaena); (Guthrie, 1984: e.g. bison, elk, reindeer, musk ox, moose). In the course of the current investigation, however, it has become clear that morphological comparisons can be made even more precise and meaningful with the addition of chronological evidence (e g. reliable radiocarbon determinations), especially for the Late Glacial. For instance, evidence of further body size changes for British wild horses of the Late Glacial through to the early Post Glacial was recovered in which the horses were found to be more robust during the Allerød/Younger Dryas (compared to those of the Bølling), and even smaller and more gracile in the Early Boreal. The latter, however, needs further verification with additional material and dating evidence for both Britain and the Continent (see section 6.7).

During the middle to later Post Glacial, a further reduction in horse body size is evident for Britain and western Europe, and probably resulted from the first appearance of domestic animals in the Post Glacial (Late Neolithic/Beaker to Bronze Age and later). This size change was characterised by a change in proportions and an increase in variability. Individuals also appeared to exhibit a significant reduction in body weight (i.e. increase in gracility) and more variation in withers height. However, not all middle to later Post Glacial specimens were found to conform to this profile In fact, a rogue specimen (a first phalanx) from the Late Bronze Age site of Runnymede Bridge, Surrey was clearly larger (i.e. more robust) than the others, and may have originated from a larger variant of domestic animal at the site. Alternatively, it may have been a contaminant from older deposits (i.e. have its origins in the Late Glacial);

however, its overall proportions suggest that this is unlikely. In order to explore these issues further, additional radiocarbon dates as well as further evidence of variation in the horse samples from Post Glacial sites such as this one are required. Once again, this highlights the important role which reliable chronological data can play in studying the morphology of ancient horses.

Comparisons with continental samples have also proved invaluable throughout this morphological study. For example, the current investigation found that a size difference exists between the Late Glacial wild horses of Britain and the Continent. During the Bølling in particular, British horses were significantly larger than continental ones. In contrast, similar investigations within the Post Glacial have not been so fruitful. At present, few British middle Post Glacial (i.e. Late Neolithic/Beaker) samples are good enough for morphological comparisons with contemporaneous finds on the Continent (i.e. British samples are small and contain few postcranials).

6.3.3 Body size in relation to geography, the environment and human influence

The environment has played a key role in the shaping of both British and continental horses of the Late Pleistocene and Holocene, and the evidence given in the current study supports this. First, it was possible to correlate clear body size stages (see below) with the contemporaneous environmental (i e. climate and vegetation) events in Britain. In addition, comparisons with continental samples have revealed that the sturdiness of British horses during the Bølling interval was probably a result of environmental differences between the two regions, rather than geographical isolation which was incomplete at the time. Furthermore, as a result of this investigation, it is now apparent that Late Pleistocene horse body size (primarily body mass) was determined by climate rather than vegetation (i.e size change as a result of ideas relating to Bergmann's Rule rather than nutrition) Throughout the transition from the Mid-Devensian to the early Post Glacial, size changes occurred in accordance with significant climatic upheavals.

Body size change in early domestic horses of the Holocene was also discovered not to have been completely independent of climatic and vegetational factors It appears that variation in body size during the middle to later Holocene involved a combination of variables (e g. geography, environment, anthropogeny), rather than one significant factor (e g climate). As the Post Glacial progressed, anthropogenic factors

were becoming more influential, and by the Late Bronze Age in Britain, it is probable that horses were being forcibly imported from other regions. The morphological variation which has been detected in British horses of this period was probably due to the successive exchanges which took place between Britain/Ireland and the 'domestication centres' within continental Europe or further east. Furthermore, these changes were almost certainly reinforced by humans in the course of developing different breeds through artificial selection and reproductive isolation. At present, however, evidence is lacking for distinguishable regional breed types.

Regarding morphological comparisons between Britain and the Continent in the later Post Glacial (e.g. Late Bronze Age), horses in western and central Europe (e g. Sweden and Germany) were found to correlate well in body size with contemporaneous British material Additionally, a literature search uncovered specific morphological evidence relating to the early domesticates in continental Europe. Uerpmann (1990) suggests data in support of two distinct scenarios: 1) a trend toward the decrease in body size as well as a widening of variability during the Late Neolithic to Bronze Age in western Europe (e.g. south-western France and southern Spain); and 2) in central Europe (e.g. southern Germany), an increase in size and evidence of sturdier animals (i.e. in comparison to the decrease in size in western Europe) which indicates that domestics were being imported from other areas (e.g. to the east). In the current study, British middle to later Post Glacial horses were found to adhere to the pattern as described in scenario (1) above

6 3.4 Final thoughts

In the course of this morphological investigation of ancient horses, a series of body size 'stages' were discovered through the Mid-Devensian to the early Post Glacial: 1) a decrease from the Mid-Devensian '*gallicus*' to '*arcelini*' of the Late Glacial; 2) an increase in body size (i.e. more robust postcranials) with temperature decrease from the Bølling to the Younger Dryas according to ideas related to Bergmann's Rule; and 3) a reduction in body size with an increase in temperature as well as a decrease in availability of suitable food resources (i e. limited food supply) from the Younger Dryas to the Pre-Boreal/Boreal of the early Post Glacial. However, because slight differences between small samples (e g some sample sizes of n=1) could be construed as sampling error, it must be noted that a degree of caution should be attached to some of these determinations. As a result, future investigations must

strive to incorporate larger samples in order to confirm differences between assemblages from particular periods (e.g. Bølling versus Younger Dryas, Bølling versus Pre-Boreal)

It is now possible to develop further an issue relating to comparisons between British samples and those from the Continent. Although the morphological evidence and statistical testing related in this study point to a significant difference in size between particular Late Glacial (i.e. Bølling) samples from Britain and the Continent (e.g. at the well-dated Bølling sites of Andernach and Gönnersdorf, Germany), particular chronological and environmental elements on the Continent remain unexplored. For example, the causes of morphological variation need further testing with regard to assemblages such as Solutré, France which cover a longer chronological range (e.g. c. 15,000-12,500 BP) than any in Late Glacial Britain. Because a range of climatic/vegetational environments may have existed throughout such a long interval of continuous presence (i.e. Pre-Bølling together with Bølling at Solutré), it is also possible that a variety of morphological forms existed. It is necessary for continental workers to seek out reliable, multiple dates for morphologically distinct material (if any actually exists), a feat which has now been accomplished for horses of the British Late Glacial (i.e. Bølling versus Younger Dryas).

Attention must also be drawn to the another issue relating to the causes of body size change among mammals, particularly during the early-middle Holocene. Problems often arise when workers choose *a priori* to favour one influential environmental factor (e.g. climatic, vegetational) over another. For instance, Uerpmann (1990) attributes the size reduction of Post Glacial populations of wild horses in western/central Europe (e g. early Post Glacial to the Neolithic in France) solely to vegetational changes such as forestation from c.10,000-6,000 BP, with no mention of the potential climatic effects. He describes the animals of the mid-late Atlantic (c. 6,500-5,000 BP) of central Europe as small "forest horses", and attributes their size to the effects of tree cover. Although Uerpmann (1990) suggests that this scenario is analogous with the so-called 'island effect', this does not sufficiently explain why body size modification in animals such as horses may have helped them survive in a woodland habitat In addition, no mention is made of other potential effects such as climate. Evidence provided by the current study suggests that a combination of variables (e g. geography, climate, vegetation and anthropogeny) was responsible for horse body size changes during the early-middle Holocene Clearly, all the potential

variables need to be fully assessed before safe conclusions can be drawn for the horses of a particular period.

Finally, the importance of morphological comparisons between ancient and modern horses must not be overlooked. These contrasts allow for conclusions to be made regarding the assessment of overall body size. One key example relates to the body size comparisons between the modern wild horses (i e. Przewalski's horse) and their ancient wild relatives. Although the Przewalski's horse is currently described as an animal of "stocky" or "robust" build (e.g. Groves, 1994), in actuality, the evidence presented here suggests that these animals are less robust, being even 'lighter' in body weight than the Late Glacial and early Post Glacial wild horses of Europe. Interestingly, this creates a new perspective from which to view ancient (including the ancestors of Przewalski's horse) as well as modern wild horses. Accordingly, it seems inaccurate to describe the ancient animals simply as 'dwarfs' of the Late Pleistocene (e.g. Forsten, 1988), when in reality they were even more stocky and robust than the heavy-set living animals to whom they are supposedly related.

6.4 Taxonomy and relationships unravelled

The author has managed to clarify, as far as possible, the taxonomy of Late Pleistocene/Holocene British and European horses. Relevant information was arranged into an easy-to-read diagram (see chapter 2: table 2.2) in which priority names (i.e. nominate species/subspecies) were highlighted amongst all those which are currently available (i e. priority names plus synonyms). Once the key information had been gathered and investigated, it became evident that some taxonomic problems could be tackled through many of the detailed assessment methods summarised above. Indeed, morphological and chronological evidence presented in this work serves to prove that some groups of fossil horses have previously been wrongly classified. For instance, the Bruniquel (France) horses have been found to belong within the '*arcelini*' group (of *E. ferus*), rather than the '*gallicus*' group as was assumed by following Owen's naming of them as "*E. spelaeus*". Additional examples which have resolved taxonomic issues are given below.

(1) To what extent do British wild horses of the Mid-Devensian and Late Glacial conform to the suggested European taxonomy?

The common practice of haphazardly naming species and subspecies of Late Pleistocene horses (e.g. Nobis, 1971) has confirmed the author's reasoning for calling all British wild horses of this period *Equus ferus*. As a result, the use of contentious subspecific 'tags' was avoided (e.g. '*gallicus*', the 'priority' subspecific name of Prat (1968) was used for the Perigordian Solutré horse instead of names such as '*E. f. solutreensis*'). However, the current author found subspecific names such as '*gallicus*' and '*arcelini*' (Guadelli's (1986) name for the Magdalenian horse at Solutré) to be useful in making comparisons (e.g. morphologically) between British horses and those from other geographical areas across Europe.

In the current study, both the '*gallicus*' and '*arcelini*' forms were detected within British assemblages. They were found to differ from one another in the proportions of their teeth and metapodials, '*arcelini*' being the smaller and more gracile form. Furthermore, comparisons between Britain and the Continent have revealed that the British '*arcelini*' was a larger (i.e. heavier) variant. In the light of these revelations, however, the current author believes that it is not necessary to rename the British form as new subspecies. Instead, references should continue to be made to the existing nomenclature, but with sustained caution. In order to define regional variation without creating new names, it is essential to appreciate the factors which are known to have influenced horse body size (e g. the environmental differences between Britain and the Continent) during the Late Pleistocene.

(2) How do British horses of the early to later Holocene conform to the suggested taxonomy?

The author believes that Uerpmann's (1990) suggested taxonomy for the wild horses of the early Holocene is the most straight-forward of those proposed thus far. His scheme includes: 1) *E. ferus lusitanicus* Uerpmann,1990: a small Iberian wild horse; 2) *E. ferus scythicus* Radulescu and Samson,1962: a large form from south-eastern Europe/Asia Minor; 3) *E. ferus ferus* Boddaert,1785: a large form from the continental steppes of eastern Europe; and 4) *E. ferus sylvestris* v. Brincken,1828: a medium-sized form from western Europe.

Because the size variation detected between Late Glacial British and continental horses (i.e. British ones being larger) may have translated itself to the early Post

Glacial animals, the British horses of the Pre-Boreal/Boreal possibly retained a different morphology to that of western/central European horses (i.e. '*E. f. sylvestris*' of Uerpmann, 1990 above). However, some key concerns have been identified in attempting to resolve this issue. First, two outcomes are possible for the taxonomy of British Post Glacial horses: 1) inclusion within Uerpmann's (1990) scheme if early Post Glacial wild horses are acknowledged as being of the same morphotype as '*E. f. sylvestris*'; or 2) exclusion from the scheme due to the lack of middle to later Post Glacial wild animals. The latter suggestion is more acceptable because the former is at present unprovable due to the lack of good samples sizes. Also, reliable data are lacking which bridge the chronological gap within the Boreal throughout Britain and western/central Europe. Thus, the current author has found it impossible and unreasonable to 'fit' British Post Glacial horses into a continental scheme. If, however, the supporting evidence (e.g. a sufficient number of well-dated samples) becomes available through future excavations, it is recommended that these judgments be reassessed.

It must be stressed again that the naming of subspecies for regional forms (e.g. as in Uerpmann, 1990) can become a dangerous practice if environmental issues are not clarified. It is also essential to know (as far as possible) the results of morphological comparisons between contemporaneous samples of the variable forms. At present, these criteria do not appear to have been fully investigated on the Continent Therefore, the author suggests that these issues be developed further in any future investigations of Holocene wild and early domestic horses.

(3) What of domestic horse origins?

Specific evidence (e g. morphological, distributional) derived from the current study of fossil/sub-fossil horse material could be utilised to resolve some of the confusion regarding the origins of domestic horses. In particular, the morphological and environmental data support the author's sentiment that the 'types' of divergent wild stock (e g. steppe, forest, plateau/desert, tundra) suggested in many previous works are not valid It must be noted, however, that Uerpmann's (1990) naming of wild ancestors (see above) is more acceptable because no specific environmental 'tags' are attached to the regional taxonomic groups. Instead his framework is based upon the morphological variation detected between horses of the various geographical regions of Europe.

The process of naming wild species based on the morphology and/or behaviour of domestic animals (i.e. creating wild 'types' from domestic 'types') is also deemed unsound. As well as consigning animals to particular habitats and behaviours, the use of these terms neglects the available evidence for behavioural, physiological and morphological flexibility among horses (ancient and modern) living under a range of environmental conditions (see chapters 1 and 5). Moreover, it is clear that in order to propose ancestors, unequivocal fossil evidence (e.g. chronological, morphological) must be supplied, an issue which was overlooked by those who previously made these designations (e.g. Ewart, 1909-10).

One thing is certain regarding the origins of modern domestic horses: neither the Przewalski's horse nor the tarpan can be their direct ancestors. At best, they can only be considered as wild relicts of the Eurasian ancestral populations. So, what roles did their closest ancestors play in domestic horse origins? Were early domestic horses directly derived from the ancestors of the Przewalski's horse and/or the tarpan? These questions have yet to be answered satisfactorily because key chronological and morphological data are lacking. This investigation has proved that well-dated Late Glacial and early Post Glacial evidence is essential so that relationships can be established between regional 'forms' across Eurasia. In this case, dated horse material from eastern Europe and Asia is needed for direct comparisons between eastern samples and contemporaneous ones in Britain and north-west Europe. Also, see below for alternative evidence (e.g. molecular) which sheds further light on the issues of taxonomy, origins, and relationships.

(4) What of ecotypes and 'primitive' native ponies?

The current author believes that the ecotype theory for Late Pleistocene and Holocene horses also has severe drawbacks It appears to be too strict and tends to lead to the pigeonholing of particular suggested 'types' (see above). Instead, a more reliable practice is to pinpoint particular adaptations to environmental variation, and to feature the flexibility and adaptability of the animals being discussed This has been the aim of the current study.

Regarding the native pony question in Britain (particularly the Exmoor pony), no evidence has been discovered in the fossil record suggesting a direct link between modern breeds and ancient wild horse populations. There is no disputing that free-living native ponies (e g. Exmoor, Shetland) are well-adapted to the environmental

(e.g. climatic and vegetational) conditions of their respective regions. Indeed, they share the potential for a keen adaptability with their wild ancestors (i.e. Late Glacial/early Post Glacial horses) as well as the modern Przewalski's horse. However, no unambiguous evidence exists which proves that native ponies are descended directly from Late Glacial British and European horses. Indeed, the radiocarbon evidence militates against it. Instead, it is likely that these modern animals are descended from the early domestics of Britain and north-west Europe, some of which may have been members of free-living or feral populations. Living for centuries under rigorous environmental conditions probably allowed them to develop their present-day adaptations. So-called 'primitive' ponies, such as Exmoors, most likely were kept phenotypically and genotypically homogeneous through human interference (e.g. artificial selection). See below for a discussion of attempts to resolve wild/domestic horse relationships using molecular evidence.

In conclusion, it seems clear that many theories (e.g. regarding ecotypes, wild and domestic 'types') originally were proposed to make more acceptable the idea of horses living in inhospitable environments. In order to shift future ideas away from this rigid perception, the current author considers it more appropriate to define horses as ecological entities rather than as ecotypes, 'types', or even subspecies. Accordingly, in discussions of taxonomic and relationship issues, attempts should be made to highlight the horse's flexibility and adaptability as eagerly as the factors which are thought to constrain its behaviour, physiology and morphology.

6.5 Investigating relationships: the molecular evidence

A fairly long history exists regarding the utilisation of molecular, biochemical and cytological studies to explore relationships between different species and breeds of equids. Some of the first investigations involved analyses of protein polymorphisms and chromosomes in horses, and they were carried out by workers such as Benirschke *et al.* (1965), Clegg (1974), Blokhuis and Buis (1979), and Ryder *et al.* (1978, 1979). More recently, however, genetic studies have become the investigation of choice. One of the first wide-ranging relationship studies was carried out by George and Ryder (1986) in which they performed restriction enzyme analyses of mitochondrial DNA (mtDNA). Using a range of horse samples including the Przewalski's horse, various domestic breeds as well as other *Equus* species (e g zebras), it was deduced that there

exists up to 0.55% sequence divergence among the 'true' horses (i.e. *E. ferus* and *E. caballus*). Subsequently, Higuchi *et al.* (1987) performed a mtDNA sequence study involving extinct and living *Equus* species and found the extinct quagga (*E. quagga*) to be more closely related to the extant zebras than to the 'true' horses (e.g. *E. caballus*).

An important breakthrough came when palaeontologists began to discuss molecular data for horses in relation to the available fossil evidence. Forsten (1992) was the first to provide a discussion of this issue as well as a mtDNA-based time-table for the extant *Equus* in relation to the known morphology of ancient and modern animals. Subsequently, however, others have chosen to disregard the fossil evidence in favour of genetical results gleaned solely from modern animals. For instance, Xu and Arnason (1994) discovered extensive heteroplasmy resulting from variable numbers of repeats in a short motif of the control region in an investigation of the mtDNA sequence of the "domestic horse". Other studies include Ishida *et al.* (1994) who provided the complete sequence for the 'D-loop' control region of the mtDNA for three individuals of one particular domestic breed (i.e. the Thoroughbred). Later, Ishida *et al.* (1995) sequenced approximately 270 base pairs (bp) of the mtDNA control region for a small array of domestic breeds, the Przewalski's horse, and other *Equus* species. In a calculation of substitution rates, Ishida *et al.* (1995) found that the Przewalski's horse's rate was within the range of variation for domestic breeds.

All of the above studies are severely limited in the conclusions that can be drawn about horse relationships, because of the very small sample sizes and limited range of breeds. Thus, it is necessary to return to Forsten's (1992) ideas of combining molecular results with those of palaeontological studies and to develop them further. The present author was directly involved in a recent attempt by Lister *et al.* (1998) to explore the origins of domestic horses and their relationships to putative wild ancestors (see fig. 6.1). The palaeontological evidence (from the current and other investigations, e.g. Guthrie, 1990a; Kahlke, 1995) presents a scenario in which wild horses were extremely widespread across northern Eurasia during the Late Pleistocene. Although their subsequent fate is not entirely known, it is clear that the remnant wild populations must have formed the stocks from which the first domesticates were derived As mentioned earlier, it is also probable that the wild Przewalski's horse survived in the east (i.e Mongolia and surrounding regions) as one of these populations Lister *et al.'s* (1998) study included comparisons of mtDNA sequence data for a range of extant equids (a wide range of domestic breeds and the Przewalski's horse). In addition, a

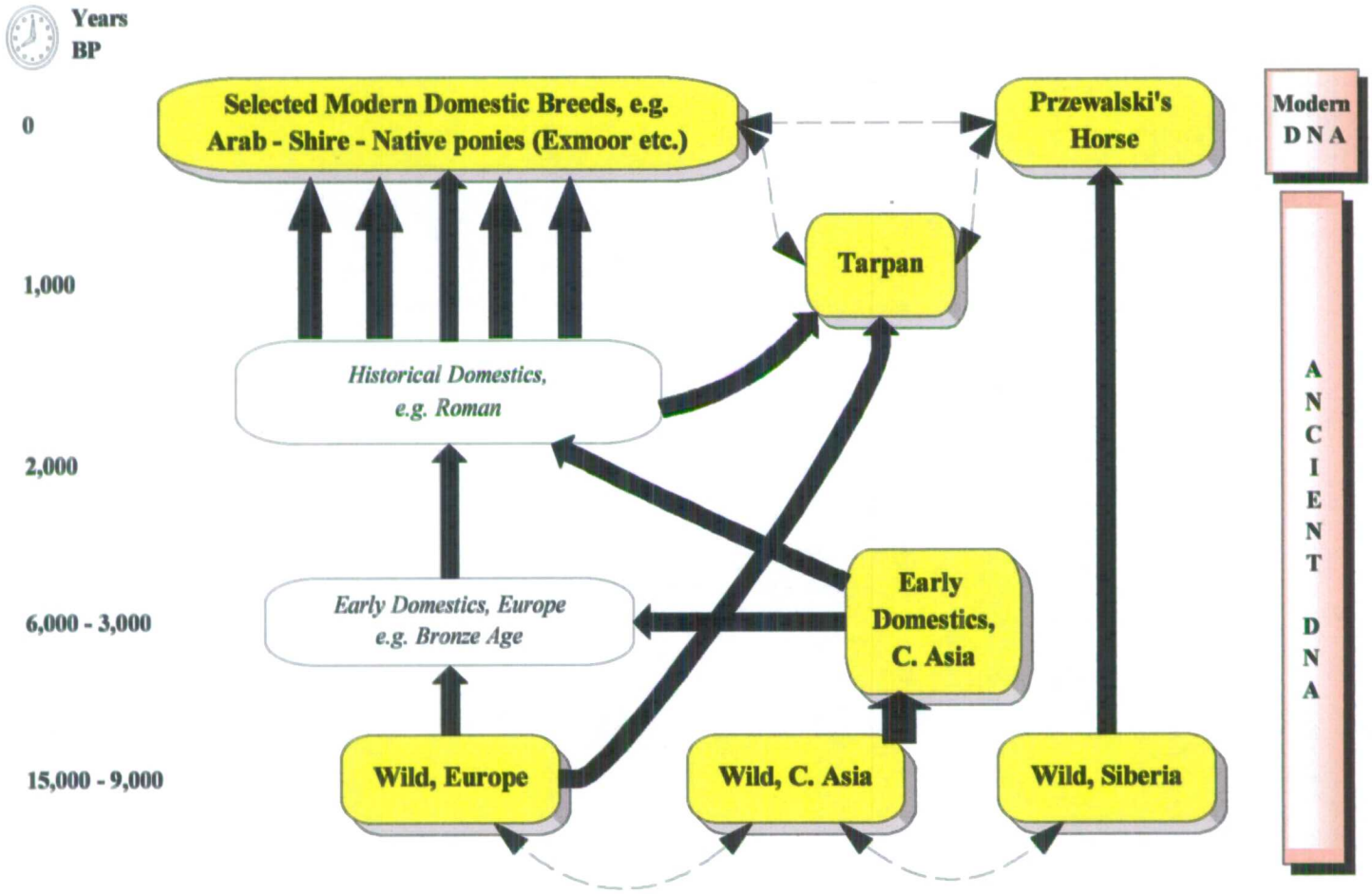

Fig. 6.1. Schematic diagram representing possible routes to domestic horses. Broad arrows indicate various alternative ancestral pathways. Dashed lines represent possible gene flow among broadly contemporaneous populations. Populations from which samples were analysed in Lister *et al.*'s (1998) study are highlighted in yellow.

novel attempt was made to include data retrieved from samples of ancient material, representing a range of fossil and historical populations implicated in domestic horse origins (e g Late Pleistocene wild horses from Europe/Eurasia, archaeological material from central Asia, wild relicts such as the tarpan: see fig. 6 1) Furthermore, because morphological and/or chronological studies have also been conducted (in the current study) on much of this material, some resulting molecular information appears even more meaningful. For example, a reliably-dated and well-studied horse bone from Kent's Cavern, Devon (c. 12,300 BP) has also yielded molecular results (i.e. ancient DNA: a 90 bp 16S rRNA sequence, fully homologous with modern horse). For the first time in a study of horse evolution, data provide both a precise age for the individual animal as well as its recovered DNA

In the same study (Lister *et al.*, 1998), considerable variation was detected on examination of a 608bp sequence of the mtDNA control region for modern horses (Przewalski's plus domestics, n=29). The amount of sequence divergence among modern breeds appeared to be much greater than could have arisen within any plausible timescale of domestication (i.e. by c. 5,000 BP according to current archaeological estimates: see Levine, 1990). Hence, this must reflect a more ancient haplotype diversity than has been suggested previously. Moreover, the various haplotypes were distributed randomly across modern breeds and breed types. There is no evidence in Lister *et al.'s* (1998) data to support the idea that the Przewalski's horse had a long and separate history from extant domestics. In fact, these analyses suggest that this wild horse is no more distant genetically from the breeds of domestic horse than the domestics are from one other. Taken together, these genetic data appear to be consistent with the available palaeontological evidence. The extensive population of wild caballine horses across Britain, continental Europe and Asia through much of the Middle to Late Pleistocene must have accumulated a considerable amount of mtDNA variation, and from samples of this population come the ancestors of modern domestic breeds as well as the extant Przewalski's horse.

The modern horse data available to date do not distinguish single from multi-regional domestication events. The extent of modern haplotype diversity may, however, reflect an input of wild animals from different areas Interestingly, similar results exist for other domestic animals (e g cattle· Bailey *et al.*, 1996; dogs: Vila *et al.*, 1997) where the various breeds share a range of haplotypes. Above all, it is evident that these new data for horses do not support the widespread belief that the modern

phenotypic groupings are derived from the suggested divergent wild stocks (e.g. wild 'types': tundra, plateau/desert, forest, steppe horses). This also appears to corroborate the taxonomic conclusions related above (see section 6.4: question 3). Furthermore, Lister *et al.* (1998) propose an alternative model in which domestic horses emanated from sub-samples of a wild stock which was distributed over a vast geographical region, large enough to have accumulated within it considerable pre-existing haplotype diversity.

Regarding the endemic or native ponies (e.g. Exmoor and Shetland ponies), no evidence was uncovered by Lister *et al.* (1998) to support the supposed 'primitiveness' of these breeds. However, a recent microsatellite study by Baker *et al.* (1998) involving a large sample of Exmoors (n=103) in comparison with other breeds of pony and horse reveals data confirming the genetic distinctiveness of the breed. However, microsatellites are very fast-evolving and the study of Baker *et al.* (1988) does not demonstrate that the Exmoor is any more divergent than any other breed which has enjoyed a period of isolation. Therefore, this study does not challenge the conclusion of the present work. Now that reliable contrasts with supposed ancestors have been investigated, it is unrealistic for Exmoors (or any other native British ponies for that matter) to be direct descendants of the last wild horse populations of Britain (i.e. horses of the early Post Glacial). See section 6.7 for ideas of future research regarding this area of study.

6.6 The 'role' of the horse: a discussion

Before discussing the horse's role in the Late Pleistocene to Holocene (Mid-Devensian, Late Glacial and Post Glacial), it is necessary first to highlight the issue of status (i.e. whether to name an animal or population as wild or domestic). There is much discussion and debate about what constitutes a wild versus a domestic animal. A wild animal is one which lives under the conditions of natural selection without any intervention from Man regarding their nutrition, breeding and behaviour. On the subject of non-wild and domestic animals, it is necessary to make the distinction between two key terms. 'tame' and 'domesticated'. According to Teichert (1993), a tame animal is a formerly wild one which has been influenced in order to "extinguish the temptation to escape"; while a domesticated animal is a wild one which has been transformed into a domestic form "by selecting and combining mutations which

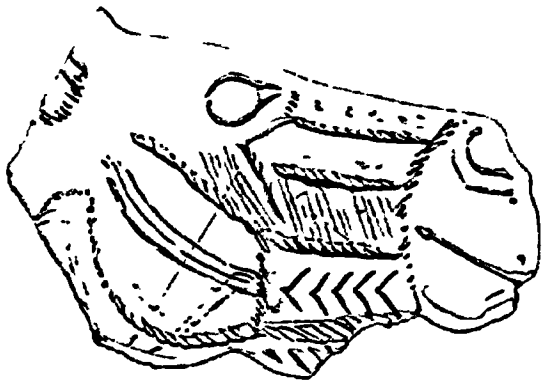

Fig. 6.2. Engraved horse head from Saint-Michel d' Arudy, France. The engraving exhibits "detailed facial lines" sometimes interpreted as representing a halter or harness. (from White, 1989).

existed already in the wild form". Finally, the key to domestication is the human use of selective measures to "interfere with the natural biology of propagation", an undertaking which allowed domestic animals to develop modifications which their wild predecessors did not display (Teichert, 1993).

Although there is no disputing that present-day wild and domestic animals are represented by the Przewalski's horse and the modern breeds respectively, the case is not so straightforward regarding ancient populations. Throughout the Late Pleistocene and early Holocene, the horses are thought to have been wild, and there appears to be little or no clear evidence for animal husbandry in Europe before the Neolithic (e.g. White, 1989 with reference to France). However, previous work on the Continent (e.g. Martin, 1911; Bahn, 1978, 1980, 1984) led to the theory that some form of early taming or domestication of horses did take place. The evidence is thought to include worn incisors supposedly representing the so-called stable 'vice', crib-biting as well as representations of trappings (e.g. a halter or harness) in Palaeolithic art (e.g. fig. 6.2). At this stage, it appears that the available evidence is at best inconclusive and not widespread enough to support the existence of tame or domestic horses during the Mid-Late Devensian (or Weichselian). Furthermore, because the present author has been unable to substantiate any of the continental claims on British material, the 'true' status of horses in Britain during this period must be considered as that of wild horses.

During the Post Glacial, an altogether different issue arises at the transition from wild animal to domesticate. It is clear that wild horses survived in Europe through the latest Late Glacial and into the early Post Glacial; however, it has not yet been discovered when, where or how the 'event' first occurred. Because there is limited

evidence for domestication pre-c. 4,500 BP, workers such as Uerpmann (1990) assume that horse finds from the preceding Post Glacial intervals throughout Europe come from wild animals until proven otherwise. Although the author currently agrees with this sentiment, it is expected that future investigations will provide concrete evidence in support of either wildness or domestication for the horses of this problematic period. The discussion below aims to shed light on this and other issues relating to the interactions of horses and humans, with special reference to comparisons between Britain and the Continent.

6.6.1 Horse/human interactions in the Late Pleistocene to middle and later Holocene

The horse as a wild animal

Abundant evidence exists as proof that wild horses were a key prey species for humans as well as other predators (e g. wolves) in the Late Pleistocene. For the Late Glacial intervals (Bølling, in particular), many sites exist where accumulation was the result of human occupation rather than abiotic factors or non-human predators. These assemblages have provided direct evidence of hunting and butchery by humans in the form of smashed, cutmarked and/or burnt bones (and in some cases teeth). Although a majority of the Late Glacial sites with horse listed in the gazetteers (chapter 4) are humanly accumulated assemblages, non-humanly accumulated sites are also available. To avoid bias, the current author specifically chose some samples (e g Wolf's Den, Somerset) for investigation based on their apparent lack of archaeological evidence. Ultimately, a subset of results assembled in this work proved useful in tracking the development of the interaction through time.

The horse as a domestic animal

Although the domestication process is not a central theme in the present study, it is worth mentioning in relation to European Post Glacial horses Some of the key morphological attributes of domesticated horses were discussed in chapter 5, and it is now possible to address the topic once again with respect to additional evidence (e g trappings, animal burials, chronology) on the Continent and in Britain.

As mentioned earlier, the details relating to the first domestication 'events' are not known with a great deal of certainty Levine (1993) suggests that the horse had probably been domesticated or tamed by the Late Neolithic or "Eneolithic", and that by

the Early Bronze Age, the evidence of domesticated animals was more widespread, especially to the west of "their apparently original distribution". Uerpmann (1990) provides further evidence of local domestication 'events' for western, central and eastern European wild populations, although he does concur with Levine (1993) that the first domestication of horses probably occurred earlier in south-eastern areas of Europe. Some of the first domesticated or tamed horses in eastern continental Europe were probably present at Dereivka (Ukraine), an Eneolithic habitation site dating to c. 5,500-5,000 BP. Substantiation comes from Anthony and Brown (1989, 1991) who discovered trappings (e.g. possible cheek pieces), ritual burials, and evidence of so-called 'bit wear'. Although this probably confirms the presence of domestic horses at the site, it does not serve as proof that the assemblage was composed entirely of domesticates. Accordingly, Levine's (1990) investigation into the age and population structure of the Dereivka horses has revealed that the majority of individuals found there were probably wild animals which had been hunted. There is no disputing that Dereivka is an important site with respect to the detection of the earliest domesticated horses. In stark contrast, contemporary evidence from other areas (e.g. Britain, western/central Europe) appears to be far less forthcoming regarding the key information of this transitional stage.

It is now possible to highlight some of the key issues relating to the transition from wild to domestic horses in western regions. In particular, when and where did this 'event' take place in Britain? First, the results of the present thesis show that there was not a 'true' (i.e. continuous) transition from wild to domestic in this far western region. The main evidence in support of this conclusion comes from the chronological record which has exposed a wide gap in distribution throughout Britain during key periods (Mesolithic to Late Neolithic: c. 9,000-4,000 BP). This being the case, other potential scenarios are available. Because local domestication was not possible (i.e. the extinction of the wild, potentially ancestral population), it is more likely that domestic animals were present in Britain (and Ireland) as a result of successive importations from other regions (i e the Continent) Furthermore, the morphological analysis of dated material carried out in the current study suggests that these events probably occurred in Britain somewhat later than in many other areas of Europe.

Although the true status of all British horses dating to the mid-Holocene and later (i.e. post-c. 4,000 BP) is not entirely clear, the majority of sites which yielded these horse remains have provided secure evidence of human activity (e g. artefacts,

non-horse domestic animals, agriculture, burials). The present data include 12 reliable radiocarbon dates from eight human settlement sites (mid-Holocene and later). With this in mind, it is possible to make practical suggestions regarding the status of horses in Britain after c. 4,000 BP. Even without an abundance of direct evidence for domestication, the human/horse relationship from Late Neolithic times most probably was one of domesticator/domesticate. There are at least three lines of evidence in support of this proposition:

1) From the Late Neolithic (c. 3,700 BP for horse at Grimes Graves, Norfolk) through to Iron Age/early Roman (c. 1,900 BP for horse at Kirkburn, Humberside) the human/horse relationship is exemplified by the presence of deliberate "ritual" burials, and in some cases evidence existed for animals which were well-cared for (e.g. Grimes Graves: see Clutton-Brock and Burleigh, 1991b).
2) A number of Late Bronze Age sites have yielded morphological evidence for horses of varying and small body size (see chapter 5) as well as ones possibly used by humans for particular purposes. For example, at Runnymede Bridge, Surrey some horse remains exhibit pathologies such as extoses and ankyloses supposedly caused by draught work (Done, 1991).
3) Evidence of "horsemanship" (Britnell, 1976) exists in the form of horse trappings found at mid-late Holocene sites (e.g. antler cheek pieces as a key element of horse's bridle from Late Bronze Age sites such as Heathery Burn Cave, Co. Durham (see gazetteer entry in chapter 4).

Because it is not yet possible to know the full extent of domestication in early times, the status of particular populations sometimes appears ambiguous. As a result it may be difficult to consider all British later Post Glacial horses (up to the Iron Age) as 'true' domesticates according to the definition given above. For example, it is conceivable that free-living domestic horses (i.e. feral) were allowed to roam within areas close to those human settlements in which confined, tame animals could also be found Both Neil (1977) and Harcourt (1979b) have suggested possible scenarios for particular later Post Glacial sites which involved free-living animals being rounded-up Iron Age sites such as Gussage All Saints (Dorset) and Danebury (Hampshire) have yielded unusual assemblages in which very young horses were lacking. According to Harcourt (1979b), this evidence (in comparison to that provided by other domestic

fauna) suggests that horse breeding was not practised at these sites. At Gussage All Saints, Neil (1977) believes that "self-sufficient groups were bred and kept away from the settlement site"; while Harcourt (1979b) imagines these animals to have been "periodically rounded up, caught and trained". Although each scenario differs slightly from the other, they together highlight the potential for free-living, domestic (or tame) horses to live alongside humans and their settlements, just as they do today.

6.6.2 Final thoughts

There are probably several factors which caused a deterioration in wild horse numbers within Britain and adjacent areas (i.e. western and central continental Europe) at the end of the Late Glacial. One of the main reasons for this decline lies in the fact that a fundamental change in the environment during the early Post Glacial produced conditions of ecological stress for wild horses. These populations were almost certainly forced to compete with humans, and later their livestock and/or agriculture, for space and suitable environments (i.e. good grazing land), and as a result, the pressure became inescapable, especially within Britain. In addition, because free-living horses were probably seen as a threat to their domestic stock, humans found it necessary to kill or at least drive them away. There is certainly enough modern evidence to support the fundamentals of this theory with respect to ancient wild horses. For instance, Duncan (1992) notes that some feral horses are still seen as ecological pests because of their competition with domestic cattle for available grazing sites. This conflict often results in horse populations becoming marginalised. Similar events could have taken place on the Continent during the early to middle Post Glacial where the availability of sufficient geographical space made it possible for wild horses to relocate to areas where they were not a threat, possibly allowing them to survive locally within central and eastern Europe. In contrast, British horses most likely lacked the same opportunities as well as natural open spaces, due to a rapid decline in their numbers paired with the ever increasing geographical isolation from the Continent which occurred during this period

Whether these theories are truly viable or not, it remains clear that the role of the horse has changed through time from that of prey species to domesticated animal. Whatever form the relationship took, there is no disputing that horses have played an important role in the lives of humans throughout the Late Pleistocene and Holocene. It is also clear from the above that humans have had a significant impact on the lives of

horses. Although humans have contributed to the decline of wild horses, they have also allowed them to persist as well as thrive in the domesticated form.

6.7 Overall conclusions including ideas for future research

In the course of the current study, several issues have arisen which the author has been unable to develop more fully due to time constraints. Because these issues merit further research, an attempt has been made below to summarise the most pressing concerns. These include:

i) *Chronological investigations*

- further radiocarbon dating of key British specimens from more recent excavations to investigate particular intervals where the chronological record for horse appears to be incomplete or where the distributional limits need to be defined further (e.g. Pre-Bølling and older, Pre-Boreal/Early Boreal)
- secure dating for horses to further test the authenticity of the chronological gaps during the Pre-Boreal/Early Boreal to Later Boreal in Britain (e.g. sites in vicinity of Flixton II, N. Yorkshire) and on the Continent (e.g. sites such as Bedburg-Königshoven, Germany and Pont D'Ambon, France)
- a geographically wider-ranging dating project incorporating key material which requires direct horse dates (e.g. Irish: Newgrange; continental: Solutré and Roucadour, France)

ii) *Morphological investigations*

- comparing further the British sequences (for 'Periods 1, 2 and 3') with other regional samples (e.g. Irish, eastern continental Europe and Asia) to test the ideas of morphological variation through time and in relation to climatic and vegetational events
- developing further the evidence in the middle to later Post Glacial for variation of size and proportions in order to determine whether early breed differentiation is detectable in Britain. For example, was selection taking place for particular phenotypic characteristics (e.g. stocky, fine-limbed, taller, shorter); and what

evidence exists that horses were being utilised for different functions (e.g. riding, draught purposes)?

- developing further the utilisation the morphological study of dated material in the detection of status (wild versus domestic)

iii) *Molecular investigations*

- expanding the molecular work for ancient material by including a wider range of potential ancestral population samples, in conjunction with radiometric and morphological investigations of the same material
- exploring further the genome of the horse by sequencing a range of DNA markers from both ancient as well as a wider range of modern material including extant domestic horse breeds

Throughout this study, the present author has highlighted the importance of chronological, ecological, morphological and geographical considerations in the direct investigation of wild and early domestic horses. In addition, the present work has emphasised the value of performing an exhaustive study for a particular region using well-dated sites and material. As a result, the author has been able to shed new light on the chronological and geographical distribution of European wild horses. For instance, intervals existed during the Late Pleistocene/early Holocene in which the climate and vegetation were once thought to have been disadvantageous. The current work has proved that European wild horses, British ones in particular, could survive and even flourish in some of the harshest and most demanding surroundings, specifically those which existed during the Loch Lomond Stadial (Younger Dryas) and the early Post Glacial (Pre-Boreal/Early Boreal) of Britain.

With the above in mind, it is now possible to appreciate that horses, while living in a wild or semi-wild state, were (and still are) extremely capable animals even when faced with challenging circumstances. One has only to be reminded of the ability of wild Przewalski's horses to survive until the 1950's-60's in the arid, inhospitable Dzungarian Gobi of south-west Mongolia Even more recent examples include the hardy ponies some of which currently thrive in the upland areas of Exmoor (Devon) as well as the so-called 'wild' mustangs surviving in semi-desert habitats of North America. These indelible modern images of horse survival compel the author to

wholeheartedly embrace Guthrie's (1995) conviction that the appearance, physiology and behaviour of modern mammal species can be seen as an "Ice Age legacy". All horses living today, whatever their status (wild or domestic, feral or free-living), survive with many of the same attributes as their nearest wild ancestors, the fossil horses of Eurasia.

Appendix One

Radiocarbon Dates for Horse and Non-horse Material from Britain, Ireland and Continental Europe

For the tables in this appendix:

Entries in **BOLD** denote material newly dated by the current author

Entries in *Italics* denote unreliable dates

Radiocarbon Dates for Horse Material from British and Irish Sites

Lab No.	Site with Dated Horse Material	Radiocarbon Date	
		^{14}C Date (BP)	Error ±
OxA-4430	Pin Hole Cave	44,900	2800
GrN-6324	Kent's Cavern	38,270	+1470, -1240
OxA-5703	Hyaena Den	37,700	1200
OxA-4370	Pontnewydd Cave, Wales	35,270	860
OxA-6320	**Elderbush Cave**	**33,050**	**1000**
OxA-3896	Torbryan 6	32,100	630
OxA-6317	**Clevedon Cave**	**28,900**	**550**
OxA-4244	Shandon Cave, Ireland	27,630	400
OxA-6734	**King Arthur's Cave**	**13,320**	**130**
OxA-3413	Gough's Cave	12,940	140
OxA-4106	Gough's Cave	12,670	120
OxA-4102	Mother Grundy's Parlour	12,540	140
OxA-587	Gough's Old Cave	12,530	150
OxA-592	Gough's Cave [amino acids of M50085]	12,500	160
BM-2186R	Gough's Cave [BM-2186, recalculated date]	12,470	240
OxA-464	Gough's Cave	12,470	160
OxA-3452	Gough's Cave	12,400	110
BM-2188R	Gough's Cave [BM-2188, recalculated date]	12,380	230
OxA-590	Gough's Cave [amino acids of M50081]	12,370	150
OxA-465	Gough's Cave	12,360	170
BM-2183R	Gough's Cave [BM-2183, recalculated date]	12,350	160
OxA-589	Gough's Cave [collagen of M50081]	12,340	150
OxA-3400	Mother Grundy's Parlour	12,340	110
OxA-6669	**Kent's Cavern**	**12,330**	**90**
BM-2187R	Gough's Cave [BM-2187, recalculated date]	12,300	200
OxA-3398	Mother Grundy's Parlour	12,280	110
OxA-5698	Mother Grundy's Parlour	12,280	110
OxA-591	Gough's Cave [collagen of M50085]	12,260	160
BM-2184R	Gough's Cave [BM-2184, recalculated date]	12,250	160
OxA-5692	Kent's Cavern	12,250	110
BM-2186	*Gough's Cave [M50084]*	*12,240*	*220*
OxA-6733	**King Arthur's Cave**	**12,230**	**100**
OxA-4494	Three Holes Cave	12,220	110
OxA-6324	**Robin Hood's Cave**	**12,210**	**100**
BM-2185R	Gough's Cave [BM-2185, recalculated date]	12,200	250
OxA-6314	**Cathole Cave, Wales**	**12,180**	**90**
BM-2188	*Gough's Cave [M50086]*	*12,160*	*210*
OxA-6732	**King Arthur's Cave**	**12,150**	**100**
OxA-3890	Three Holes Cave	12,150	110
BM-2183	*Gough's Cave [M50081]*	*12,120*	*120*
BM-2187	*Gough's Cave [M50085]*	*12,070*	*170*
OxA-6666	**Mother Grundy's Parlour**	**12,040**	**80**
OxA-6311	**Fox Hole Cave**	**12,030**	**90**
BM-2184	*Gough's Cave [M50082]*	*12,020*	*120*
OxA-6631	**King Arthur's Cave**	**12,000**	**80**
BM-2185	*Gough's Cave [M50083]*	*11,970*	*230*

Radiocarbon Dates for Horse Material from British and Irish Sites

Lab No.	Site with Dated Horse Material	Radiocarbon Date	
		^{14}C Date (BP)	Error ±
OxA-1499	Three Holes Cave	11,970	150
OxA-6310	**Fox Hole Cave**	**11,920**	**130**
OxA-6735	**Mother Grundy's Parlour**	**11,910**	**110**
OxA-6326	**Dead Man's Cave**	**11,800**	**100**
OxA-6327	**Dead Man's Cave**	**11,630**	**100**
OxA-4986	*Sun Hole [?contaminated]*	*11,530*	*120*
OxA-6321	**Moughton Fell Cave**	**11,070**	**100**
OxA-6312	**Fox Hole Cave**	**10,980**	**90**
OxA-6316	**Ossom's Cave**	**10,920**	**90**
OxA-6632	**Bridged Pot Shelter**	**10,810**	**75**
OxA-6313	**Fox Hole Cave**	**10,770**	**90**
OxA-6636	**Sewell's Cave**	**10,715**	**75**
OxA-6637	**Chelm's Combe**	**10,665**	**65**
BM-604	Robin Hood's Cave	10,590	90
Birm-821	Sun Hole	10,470	190
OxA-6323	**Robin Hood's Cave**	**10,460**	**90**
OxA-6670	**Neale's Cave**	**10,420**	**75**
BM-603	*Robin Hood's Cave*	*10,390*	*90*
OxA-1785	Chelm's Combe	10,370	110
OxA-6315	**Sproughton**	**10,290**	**100**
Birm-820	*Sun Hole*	*10,280*	*200*
OxA-1788	Uxbridge VIII	10,270	100
OxA-6671	**Aveline's Hole**	**10,220**	**90**
AA-18506	Green Craig, Scotland	10,165	125
OxA-6330	Barry's Island	10,160	90
OxA-6319	**Flixton site II**	**10,150**	**80**
OxA-6328	Flixton site II	10,150	90
OxA-6633	**Wolf's Den**	**10,125**	**70**
OxA-6318	**Flixton site II**	**10,090**	**90**
OxA-1902	Uxbridge VIII	10,010	120
OxA-111	Kendrick's Cave, Wales	10,000	200
BM-1619R	Darent Gravels [BM-1619, recalculated date]	9,840	120
BM-2350	Seamer Carr	9,790	180
BM-1619	*Darent Gravels*	*9,770*	*80*
OxA-6329	Flixton site II	9,160	80
HAR-6477	*Drayton Cursus*	*4,990*	*100*
BM-1546	Grimes Graves	3,740	210
OxA-1314	Etton	3,050	80
OxA-6653	**Durrington Walls**	**3,045**	**50**
OxA-1313	Etton	3,040	80
OxA-6754	**Killuragh Cave, Ireland**	**3,020**	**45**
OxA-6654	**Fussell's Lodge Long Barrow**	**2,940**	**50**
OxA-3428	Runnymede Bridge	2,790	70
OxA-6613	**Durrington Walls**	**2,500**	**45**
OxA-1046	West Overton	2,500	70
OxA-1213	Wilsford Shaft	2,480	60

Radiocarbon Dates for Horse Material from British and Irish Sites

Lab No.	Site with Dated Horse Material	Radiocarbon Date	
		^{14}C Date (BP)	Error ±
OxA-1210	Wilsford Shaft	2,450	60
OxA-6656	**Maiden Castle**	**2,290**	**45**
BM-1709R	Lingey Fen [BM-1709, recalculated date]	2,280	110
OxA-371	Offham	2,280	120
OxA-157	Offham	2,200	120
OxA-6614	**Durrington Walls**	**2,090**	**45**
BM-1709	*Lingey Fen*	*2,050*	*50*
BM-2674	Kirkburn	1,940	50
BM-2619	Kirkburn	1,880	50
OxA-6634	**Victoria Cave**	**1,740**	**40**
OxA-6325	**Dog Hole Fissure**	**1,720**	**90**
OxA-3700	Bat Cave (Edenvale Complex), Ireland	1,675	60
OxA-3707	Plunkett Cave (Keshcorran), Ireland	1,580	55
OxA-6635	**Woolwich Green Gravel Pit**	**1,550**	**40**
OxA-1031	*Etton*	*1,440*	*100*
OxA-4738	Skara Brae, Scotland	1,380	75
OxA-6668	**Gough's Cave**	**1,190**	**40**
BM-1618R	Darent Gravels [BM-1618, recalculated date]	1,060	120
OxA-6309	**Kendrick's Cave**	**1,045**	**65**
BM-1673R	Darent Gravels [BM-1673, recalculated date]	1,020	110
OxA-6657	**Maiden Castle**	**1,015**	**40**
BM-1618	*Darent Gravels*	*980*	*80*
OxA-4739	Quanterness, Scotland	920	80
BM-1442	Swildon's Hole	860	60
BM-1673	*Darent Gravels*	*780*	*60*
OxA-3721	Drumquin, N. Ireland	635	60
OxA-6655	**Swaffham Fen**	**635**	**40**
OxA-3710	Lough Shad, Ireland	535	55
OxA-6333	Tees estuary	410	120
OxA-2077	Drayton Cursus	400	70
OxA-6331	Formby Point	390	110
OxA-3692	Curran Point, N. Ireland	380	60
OxA-6332	Tees estuary	370	100
BM-1672R	Darent Gravels [BM-1672, recalculated date]	360	100
OxA-6322	**Feltwell Fen**	**330**	**90**
OxA-6334	Tees estuary	320	130
OxA-6658	**Thatcham site I**	**285**	**40**
OxA-6473	**Kendrick's Cave**	**205**	**45**
OxA-3719	Sydenham, N Ireland	120	65
BM-1672	*Darent Gravels*	*115*	*35*

Radiocarbon Dates for Horse Material from British and Irish Sites: with specimen and stratigraphy information

Lab No.	Site and Dated Horse Material	^{14}C Date (BP)	Date Reference
OxA-6671	**Aveline's Hole, Somerset; phal I, M1.2/3**	**10,220 ± 90**	**L.M. Kaagan**
OxA-6330	Barry's Island, N. Yorkshire; premolar	10,160 ± 90	P Rowley-Conwy & S Stallibrass (pers. comm)
OxA-3700	Bat Cave, Co. Clare, Ireland; metatarsal, 2nd strat, F21099	1,675 ± 60	Woodman *et al.* (1997)
OxA-6632	**Bridged Pot Shelter, Somerset; navicular (distal sesamoid), Tufa level**	**10,810 ± 75**	**L.M. Kaagan**
OxA-6314	**Cathole Cave, Wales; lower M3, bag137 III/J(K half)/BC3**	**12,180 ± 90**	**L.M. Kaagan**
OxA-1785	Chelm's Combe, Somerset; MCIII, layer 12	10,370 ± 110	AM10
OxA-6637	**Chelm's Combe; phal I, spit IX Area "A"**	**10,665 ± 65**	**L.M. Kaagan**
OxA-6317	**Clevedon Cave, Somerset; humerus, GSM 16347**	**28,900 ± 550**	**L.M. Kaagan**
OxA-3692	Curran Point, Co. Antrim, N. Ireland, tooth, K1363	380 ± 60	AM24; Woodman *et al* (1997)
BM-1672	*Darent Gravels, Kent, metapodial, HZM 92 10007*	*115 ± 35*	*RC9*
BM-1672R	Darent Gravels [recalculated date]	360 ± 100	RC16
BM-1673	*Darent Gravels; metapodial, unregistered*	*780 ± 60*	*RC9*
BM-1673R	Darent Gravels [recalculated date]	1,020 ± 110	RC16
BM-1618	*Darent Gravels; metapodial, HZM 15.9217 (light bone)*	*980 ± 80*	*RC9*
BM-1618R	Darent Gravels [recalculated date]	1,060 ± 120	RC16
BM-1619	*Darent Gravels; metapodial, HZM 8.8535 (heavy bone)*	*9,770 ± 80*	*RC9*
BM-1619R	Darent Gravels [recalculated date]	9,840 ± 120	RC16
OxA-6326	**Dead Man's Cave, S. Yorkshire; phal III, DMC341, Sctn15/Layer3**	**11,800 ± 100**	**L.M. Kaagan**
OxA-6327	**Dead Man's Cave; magnum carpal, DMC251, Sctn 3/Level 7**	**11,630 ± 100**	**L.M. Kaagan**
OxA 6325	**Dog Hole Fissure, Derbyshire; incisor, DH 514/1**	**1,720 ± 90**	**L.M. Kaagan**
OxA-2077	Drayton Cursus, Oxfordshire; bones, from "hut", post-Saxon date	400 ± 70	AM8
HAR-6477	*Drayton Cursus; bulked bone, mixed species, E.cursus ditch: primary silt*	*4 990 ± 100*	*RC21; Amslie & Wallis (1987)*
OxA-3721	Drumquin, Co Tyrone, N Ireland, tooth, K12751	635 ± 60	AM23; Woodman *et al* (1997)
OxA-6613	**Durrington Walls, Wiltshire; radius, DW'67 S-Henge no.532 217/1971**	**2,500 ± 45**	**L.M. Kaagan**
OxA-6614	**Durrington Walls; phal I ('small'), DW'67 S-Henge no.532 217/1971**	**2,090 ± 45**	**L.M. Kaagan**
OxA-6653	**Durrington Walls; phal I ('large'), DW'67 S-Henge no.532 217/1971**	**3,045 ± 50**	**L.M. Kaagan**
OxA-6320	**Elderbush Cave, Staffordshire; MCIII, EB 3AK 80" no.24/'49**	**33,050 ± 1000**	**L.M. Kaagan**
OxA-1031	*Etton, Cambridgeshire, skull, Neolithic causewayed camp*	*1,440 ± 100*	*AM21*
OxA-1313	Etton, tooth (further samples)	3,040 ± 80	AM21
OxA-1314	Etton tooth (further samples)	3,050 ± 80	AM21
OxA-6322	**Feltwell Fen, Norfolk; MTIII**	**330 ± 90**	**L.M. Kaagan**

Radiocarbon Dates for Horse Material from British and Irish Sites: with specimen and stratigraphy information

Lab No.	Site and Dated Horse Material	^{14}C Date (BP)	Date Reference
OxA-6318	**Flixton site II, N. Yorkshire; phal I, "160E"/83.?.5**	**10,090 ± 90**	**L.M. Kaagan**
OxA-6319	**Flixton site II; phal I, 1890.51.2**	**10,150 ± 80**	**L.M. Kaagan**
OxA-6328	Flixton site II, astragalus, XB23	10,150 ± 90	P. Rowley-Conwy & S. Stallibrass (pers. comm.)
OxA-6329	Flixton site II; astragalus, WD25	9,160 ± 80	P. Rowley-Conwy & S. Stallibrass (pers comm.)
OxA-6331	Formby Point, Merseyside, skull	390 ±110	P. Rowley-Conwy & S. Stallibrass (pers. comm.)
OxA-6310	**Fox Hole Cave, Derbyshire; small cuneiform, Section VI 8/10/61 'Neolithic'**	**11,920 ± 130**	**L.M. Kaagan**
OxA-6311	**Fox Hole Cave; phal I, spit4 LayerD bag8 (1972)**	**12,030 ± 90**	**L.M. Kaagan**
OxA-6312	**Fox Hole Cave; 7th cervical vertebra, 4B LayerD below 1st Stal.**	**10,980 ± 90**	**L.M. Kaagan**
OxA-6313	**Fox Hole Cave; upper M1/M2, spit6 3/5/75 1st chamber Layer C+D bag12**	**10,770 ± 90**	**L.M. Kaagan**
OxA-6654	**Fussell's Lodge Long Barrow, Wiltshire; upper P3/P4, trench ES layer2 FUS 57**	**2,940 ± 50**	**L.M. Kaagan**
BM-2183	*Gough s Cave, Somerset; cut atlas, M50081, spit 10*	*12,120 ± 120*	*RC12*
BM-2183R	Gough's Cave [recalculated date]	12,350 ± 160	RC16
OxA-590	Gough's Cave [amino acids of BM-2183]	12,370 ± 150	AM3
OxA-589	Gough's Cave [collagen of BM-2183]	12,340 ± 150	AM3
BM-2184	*Gough's Cave; calcaneum, M50082, spit 12*	*12,020 ± 120*	*RC12*
BM-2184R	Gough's Cave [recalculated date]	12,250 ± 160	RC16
BM-2185	*Gough's Cave, metapodial, M50083, spit 13*	*11,970 ± 230*	*RC12*
BM-2185R	Gough's Cave [recalculated date]	12,200 ± 250	RC16
BM-2186	*Gough's Cave, metapodial, M50084, spit 14*	*12,240 ± 220*	*RC12*
BM-2186R	Gough's Cave [recalculated date]	12,470 ± 240	RC16
BM-2187	*Gough's Cave, metapodial, M50085, spit 16*	*12,070 ± 170*	*RC12*
BM-2187R	Gough s Cave [recalculated date]	12,300 ± 200	RC16
OxA-591	Gough's Cave [collagen of BM-2187]	12,260 ± 160	AM3
OxA-592	Gough's Cave [amino acids BM-2187]	12,500 ± 160	AM3
BM-2188	*Gough's Cave; metapodial; M50086, spit 18*	*12,160 ± 210*	*RC12*
BM-2188R	Gough's Cave [recalculated date]	12,380 ± 230	RC16
OxA-464	Gough's Cave, modified metapodial, M50024	12,470 ± 160	AM2
OxA-465	Gough's Cave, modified phal II, M49955	12,360 ± 170	AM2
OxA-3413	Gough's Cave, cut vertebra, I,1987,187	12,940 ± 140	AM18
OxA-4106	Gough's Cave cut vertebra, I,1987,191	12,670 ± 120	AM18
OxA-3452	Gough's Cave, cut phal I, M49797, layer 8	12,400 ± 110	AM18
OxA-6668	**Gough's Cave; cut astragalus, layer 5**	**1,190 ± 40**	**L.M. Kaagan**
OxA-587	Gough's Old Cave Somerset; modified phalange	12,530 ± 150	AM3
AA-18506	Green Craig, Scotland, cannon bone, NMSZ 1993 192 1	10,165 ± 125	Kitchener & Bonsall (1997)
BM-1546	Grimes Graves, Norfolk· cranial bone	3,740 ± 210	RC8

Radiocarbon Dates for Horse Material from British and Irish Sites: with specimen and stratigraphy information

Lab No.	Site and Dated Horse Material	^{14}C Date (BP)	Date Reference
OxA-5703	Hyaena Den, Somerset; tooth	37,700 ± 1200	AM22
OxA-111	Kendrick's Cave, Wales; decorated mandibular symphysis	10,000 ± 200	AM2
OxA-6309	**Kendrick's Cave; upper M1/M2, no. 083**	**1,045 ± 65**	**L.M. Kaagan**
OxA-6473	**Kendrick's Cave; upper P3/P4, no. 007**	**205 ± 45**	**L.M. Kaagan**
GrN-6324	Kent's Cavern, Devon; bone, Great Chamber cave earth A2	38,270 +1470, -1240	Campbell (1977)
OxA-5692	Kent's Cavern; cut MCIII, Black Band, Pengelly no 1855	12,250 ± 110	AM22
OxA-6669	**Kent's Cavern; ?cut upper M2, M.566/no. 1864, cave earth 1st level**	**12,330 ± 90**	**L.M. Kaagan**
OxA-6754	**Killuragh Cave, Co. Limerick, Ireland; sacrum, 93 E 175, shallow pit Cave1**	**3,020 ± 45**	**L.M. Kaagan**
OxA-6732	**King Arthur's Cave, Hereford & Worcester; upper M3, W2.21/285, 1st Hearth**	**12,150 ± 100**	**L.M. Kaagan**
OxA-6631	**King Arthur's Cave; ?cut upper P3/P4, W2.21/451, Yellow Rubble lower½**	**12,000 ± 80**	**L.M. Kaagan**
OxA-6733	**King Arthur's Cave; lower M1/M2, W2.21/484, Yellow Rubble upper½**	**12,230 ± 100**	**L.M. Kaagan**
OxA-6734	**King Arthur's Cave; ?cut (ambig.) upper M1/M2, W2.21/524, 2nd Hearth**	**13,320 ± 130**	**L.M. Kaagan**
BM-2619	Kirkburn, Humberside; metatarsal, horse burials in Neo. encl. nr. I.A.encl.	1,880 ± 50	RC17
BM-2674	Kirkburn; metatarsal, early Roman dates for horse burials	1,940 ± 50	RC17
BM-1709	*Lingey Fen ,Cambridgeshir; tibia, upper peat*	*2,050 ± 50*	*RC9*
BM-1709R	Lingey Fen [recalculated date]	2,280 ± 110	RC16
OxA-3710	Lough Shad, Co. Roscommon, Ireland; tibia, F20927	535 ± 55	AM24; Woodman *et al.* (1997)
OxA-6656	**Maiden Castle, Dorset; humerus, 70.3056, MCQ p27 Neo1 Turf line (10/9/37)**	**2,290 ± 45**	**L.M. Kaagan**
OxA-6657	**Maiden Castle; phal I; 70.3057, rotten chalk**	**1,015 ± 40**	**L.M. Kaagan**
OxA-3400	Mother Grundy's Parlour, Derbyshire; tooth, 1959 bag18, DIV,spit10/layerC(lower½)	12,340 ± 110	AM18
OxA-3398	Mother Grundy's Parlour; tooth, bag 9, Spit 3/layerC EII	12,280 ± 110	AM18
OxA-4102	Mother Grundy's Parlour; tooth, DI,SB	12,540 ± 140	AM18
OxA-5698	Mother Grundy's Parlour; cut tooth	12,280 ± 110	AM22
OxA-6735	**Mother Grundy's Parlour; upper M1/M2, no.40/M.41955, "hearth"**	**11,910 ± 110**	**L.M. Kaagan**
OxA-6666	**Mother Grundy's Parlour; metapodial, 1960, bag127, E/F XIV/XVI spit3/C(upper½)**	**12,040 ± 80**	**L.M. Kaagan**
OxA-6321	**Moughton Fell Cave, N. Yorkshire; MTIII, no. 7**	**11,070 ±100**	**L.M. Kaagan**
OxA-6670	**Neale's Cave, Devon; MCIII, M 22093, Area IX Layer3**	**10,420 ± 75**	**L.M. Kaagan**
OxA-157	Offham Kent; femur, prep. 1	2,200 ± 120	AM2
OxA-371	Offham femur, prep. 2	2,280 ± 120	AM2
OxA-6316	**Ossom's Cave, Staffordshire; incisor, O.iv/v layer C**	**10,920 ± 90**	**L.M. Kaagan**
OxA-4430	Pin Hole Cave, Derbyshire; tooth, 50 8'	44,900 ± 2800	AM18
OxA-3707	Plunkett Cave Co Sligo, Ireland· tooth, F21122, mouth of cave	1,580 ± 55	AM24; Woodman *et al.* (1997)

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Lab No.	Site and Dated Horse Material	^{14}C Date (BP)	Date Reference
OxA-4370	Pontnewydd Cave, Wales; phalange	35,270 ± 860	AM22
OxA-4739	Quanterness, Scotland, tooth, 1051	920 ± 80	AM20
BM-603	*Robin Hood's Cave, Derbyshire, MCIII+mixed species, layer OB*	*10,390 ± 90*	*RC7*
BM-604	Robin Hood's Cave humerus, layer LSB	10,590 ± 90	RC7
OxA-6323	**Robin Hood's Cave; calcaneum, "RH 38", sq A1 Level OB**	**10,460 ± 90**	**L.M. Kaagan**
OxA-6324	**Robin Hood's Cave; incisor, no.478 "478c", A0/OB spit 15**	**12,210 ± 100**	**L.M. Kaagan**
OxA-3428	Runnymede, Surrey; bone, ERB78, A6 F6.5	2,790 ± 70	AM16
BM-2350	Seamer Carr, N. Yorkshire; mandible	9,790 ± 180	RC14
OxA-6636	**Sewell's Cave, N. Yorkshire; MTIII, "18 Feb 1934"**	**10,715 ± 75**	**L.M. Kaagan**
OxA-4244	Shandon Cave, Co. Waterford, Ireland; scapula, F21158	27,630 ± 400	AM23; Woodman *et al.* (1997)
OxA-4738	Skara Brae, Scotland; tooth, skb 1977.III B7 1934	1,380 ± 75	AM20
OxA-6315	**Sproughton, Suffolk; humerus, "c.12ft dwn in peat" (1974)**	**10,290 ± 100**	**L.M. Kaagan**
Birm-821	Sun Hole, Somerset; humerus/tibia + ?upper molar, 6th/7th foot Pleist. Deposits	10,470 ± 190	Collcutt *et al.* (1981)
Birm-820	*Sun Hole; bones, including Rangifer, 5th foot of Pleistocene deposits*	*10,280 ± 200*	*Collcutt* et al. *(1981)*
OxA 4986	*Sun Hole· tooth (M1) M5 2 14 0 [?PVA contamination]*	*11,530 ± 120*	*AM22*
OxA-6655	**Swaffham Fen, Cambridgeshire; phal I, D.29817**	**635 ± 40**	**L.M. Kaagan**
BM-1442	Swildon's Hole, Somerset, metapodial, from cave deposit	860 ± 60	RC8
OxA-3719	Sydenham, Co Down, N. Ireland, tooth, 382-1919	120 ± 65	AM24; Woodman *et al.* (1997)
OxA-6332	Tees estuary, Cleveland, mandible	370 ±100	P. Rowley-Conwy & S. Stallibrass (pers. comm.)
OxA-6333	Tees estuary; mandible	410 ± 120	P. Rowley-Conwy & S Stallibrass (pers comm)
OxA-6334	Tees estuary; tibia	320 ± 130	P. Rowley-Conwy & S. Stallibrass (pers. comm)
OxA-6658	**Thatcham site I, Berkshire; upper M1/M2, T1/cutting2/12/2**	**285 ± 40**	**L.M. Kaagan**
OxA-1499	Three Holes Cave, Devon; upper M1/M2, 3H 1957 IL 8b	11,970 ± 150	AM9
OxA-3890	Three Holes Cave; modified lower M1/M2, THR FA 766, Cave entrance, '89-'91excavs.	12,150 ± 110	AM22
OxA-4494	Three Holes Cave, upper P2, THR FA 978, Upper RRS Area 9, '89-'91excavs	12,220 ± 110	AM22
OxA-3896	Torbryan 6, Devon; upper P3/P4, TB6 FA 015, N.pillar	32,100 ± 630	AM22
OxA-1902	Uxbridge VIII, Middlesex, jaw, F.312	10,010 ± 120	AM11
OxA-1788	Uxbridge VIII; molar, F.309	10,270 ± 100	AM11
OxA-6634	**Victoria Cave, N. Yorkshire; cut tibia, entr.breccia upper cave earth (P5,L6,D6)**	**1,740 ± 40**	**L.M. Kaagan**
OxA-1046	West Overton Wiltshire; skull, cutting P,West Overton formation,layer 6b WO183	2,500 ± 70	AM6
OxA-1210	Wilsford Shaft, Wiltshire; calcaneum, Wils 60 25, 7'6" Iron Age date	2,450 ± 60	AM7
OxA-1213	Wilsford Shaft; cuboid/tibia, Wils 125, 9'-9'6" Iron Age date	2,480 ± 60	AM7
OxA-6633	**Wolf's Den, Somerset; phal I, no. 1899 (25/3/45)**	**10,125 ± 70**	**L.M. Kaagan**
OxA-6635	**Woolwich Green Gravel Pit, Berkshire; MTIII, "upper section, shell bed +horse" 1.65m**	**1,550 ± 40**	**L.M. Kaagan**

Radiocarbon Dates for Non-horse Material from British and Irish Sites: with specimen and stratigraphy information

Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-3702	Alice and Gwendoline, Co. Clare, Ireland; mandibles: Arctic lemming	10,000 ± 80	Woodman *et al.* (1997)
BM-62	Antoft's Windypit, N. Yorkshire; charcoal: hazel	3,700 ± 150	Hayes (1962)
OxA-4580	Ash Tree Cave, Derbyshire; tooth: bison	40,500 ± 1600	AM 22
OxA-4446	Ash Tree Cave; tibia: human	3,730 ± 90	AM 22
OxA-5798	Ash Tree Cave; tooth: human	25,660 ± 380	AM 22
OxA-1070	Aveline's Hole, Somerset; distal humerus: human, M1.13/146	8,740 ± 100	AM 6
OxA-799	Aveline's Hole; distal humerus: human, M1.13/23	9,100 ± 100	AM 4
OxA-800	Aveline's Hole; distal humerus: human, M1.13/24	8,860 ± 100	AM 4
OxA-802	Aveline's Hole; antler (shed): reindeer	9670 ± 110	AM 4
OxA-801	Aveline's Hole; antler: red deer, M1.2/5	12,100 ± 180	AM 4
OxA-1121	Aveline's Hole; cut phal II: bovine (or ?cervid)	12,380 ± 130	AM 6
OxA-1122	Aveline's Hole; antler: reindeer	12,480 ± 130	AM 6
BM-471	Aveline's Hole; femur: human	9,114 ± 110	RC6
GrN-5393	Aveline's Hole; stalagmite assoc. with human	8,100 ± 50	RC20
Q-1458	Aveline's Hole; bone frag: human	9090 ± 110	Tratman (1977a); Burleigh (1986)
BM-497	Badger Hole, Somerset; bone: incl. otter, silty sand A2	>18,000	RC6; Campbell (1977)
OxA-679	Badger Hole; cranial frags: human	9,060 ± 130	AM 4
OxA-680	Badger Hole; mandible: human (juvenile)	1,380 ± 70	AM 4
OxA-1459	Badger Hole; mandible: human, 1783 227 31	9,360 ± 100	AM 9
OxA-4249	Ballynamintra Cave, Co. Waterford, Ireland; ulna: giant deer, layer 2	11,110 ± 110	Woodman *et al.* (1997)
OxA-4250	Ballynamintra Cave; radius: human, layer 2	4,230 ± 75	Woodman *et al.* (1997)
OxA-4251	Ballynamintra Cave; tibia: Irish hare, layer 3	1,500 ± 65	Woodman *et al.* (1997)
OxA-4252	Ballynamintra Cave; calcaneum: brown bear, layer 4	35,570 ± 1100	Woodman *et al.* (1997)
OxA-4253	Ballynamintra Cave; metatarsal: reindeer, layer 4	33,630 ± 790	Woodman *et al.* (1997)
OxA-4366	Ballynamintra Cave; tooth: red deer, layer 4	27,730 ± 380	Woodman *et al.* (1997)
OxA-8100	Barry's Island, N. Yorkshire; bone: aurochs, 7d,51504, VPT 93 LYY	9,690 ± 60	S. Stallibrass & P. Rowley-Conwy (pers. comm.)
OxA-8098	Barry's Island; bone: red deer, 7a,50892,VP 93 LYY	6,255 ± 50	S. Stallibrass & P. Rowley-Conwy (pers. comm.)
OxA-8099	Barry's Island; bone: roe deer, 7c,50561,VP 92 LW	5,855 ± 50	S. Stallibrass & P. Rowley-Conwy (pers. comm.)
OxA-8045	Barry's Island; bone: elk, 7b,50632,VPT 93 LYY	5,730 ± 60	S. Stallibrass & P. Rowley-Conwy (pers. comm)
OxA-8092	Bart's Shelter, Cumbria; bone: aurochs, 2a	4,515 ± 40	S. Stallibrass & P. Rowley-Conwy (pers. comm.)
OxA-8093	Bart's Shelter; tooth: elk, 2b	11,000 ± 65	S. Stallibrass & P. Rowley-Conwy (pers. comm.)
OxA-8094	Bart's Shelter; bone: reindeer, 2c	10,870 ± 80	S. Stallibrass & P. Rowley-Conwy (pers. comm.)
OxA-3703	Bat Cave Newhall, Co. Clare, Ireland; maxilla: red deer, 1st stratum	2,270 ± 60	Woodman *et al.* (1997)
BM-89	Blashenwell Farm, Dorset; bone: animal, tufa· middle level	6,450 ± 150	Grigson (1978)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
BM-1257	Blashenwell Farm, Dorset; bone: animal, tufa: upper level	5,750 ± 140	Preece (1980)
BM-1258	Blashenwell Farm, Dorset; bone: animal, tufa: upper level	5,425 ± 150	Preece (1980)
OxA-4582	Brean Down Shelter, Somerset; humerus: wolf	41,200 ± 1600	AM 22
BM-2102	*Bridged Pot, Somerset; bone frags: large mammal*	8,890 ± 340	*RC11*
BM-2102R	Bridged Pot [recalculated date]	9,090 ± 350	RC16
OxA-3887	Broken Cavern, Devon; ulna: Arctic hare	11,380 ± 120	AM 22
OxA-3888	Broken Cavern; metapodial: wolf	10,950 ± 95	AM 22
OxA-3205	Broken Cavern; tooth: sheep	4,930 ± 90	AM 22
OxA-3206	Broken Cavern; tooth: human	4,885 ± 90	AM 22
OxA-3207	Broken Cavern; tooth: cow (juvenile)	5,015 ± 80	AM 22
OxA-4374	Broken Cavern; jaw: steppe pika	10,180 ± 90	AM 22
OxA-4375	Broken Cavern; jaw: northern vole	10,370 ± 90	AM 22
OxA-4496	Broken Cavern; jaws: bank vole	5,770 ± 75	AM 22
OxA-4588	Broken Cavern; vole (*Microtus* sp.)	12,470 ± 110	AM 22
D-122	Castlepook Cave, Co. Cork, Ireland; bone: mammoth	33,500 ± 1200	Woodman *et al.* (1997)
I 13 625	Castlepook Cave; bone: hyaena	34,300 ± 1800	Woodman *et al.* (1997)
OxA-3602	Castlepook Cave; antler: reindeer, Wolf Hall	12,480 ± 130	Woodman *et al.* (1997)
OxA-3603	Castlepook Cave; astragalus: giant deer, Threatening Gallery	32,060 ± 630	Woodman *et al.* (1997)
OxA-3604	Castlepook Cave; ulna/tibia: Arctic fox, Hyaena Hall (upper stratum)	19,950 ± 250	Woodman *et al.* (1997)
OxA-3605	Castlepook Cave; mandible: Norwegian lemming, Wolf Hall	27,930 ± 390	Woodman *et al.* (1997)
OxA-3606	Castlepook Cave; mandible: Arctic lemming, Wolf Hall	20,300 ± 210	Woodman *et al.* (1997)
OxA-4230	Castlepook Cave; radius: reindeer, Gallery of Aged Carnivores	38,650 ± 1400	Woodman *et al.* (1997)
OxA-4231	Castlepook Cave; calcaneum: brown bear, Gallery of Aged Carnivores	33,310 ± 770	Woodman *et al.* (1997)
OxA-4232	Castlepook Cave; mandible: wolf, Gallery of Aged Carnivores	23,470 ± 300	Woodman *et al.* (1997)
OxA-4233	Castlepook Cave; rib: mammoth, Gallery of Aged Carnivores	20,360 ± 220	Woodman *et al.* (1997)
OxA-4234	Castlepook Cave; scapula: hyaena, Gallery of Aged Carnivores	24,000 ± 300	Woodman *et al.* (1997)
OxA-4235	Castlepook Cave; rib: mammoth, Elephant Hall	34,100 ± 840	Woodman *et al.* (1997)
OxA-4236	Castlepook Cave; metacarpal: reindeer, Elephant Hall	35,200 ± 950	Woodman *et al.* (1997)
OxA-4237	Castlepook Cave; metapodial: hyaena, Elephant Hall	>45,000	Woodman *et al.* (1997)
OxA-4238	Castlepook Cave; femur: brown bear, Hyaena Hall	37,870 ± 1270	Woodman *et al.* (1997)
OxA-5739	Castlepook Cave; phalanx: giant deer, Gallery of Irish Elk	32,200 ± 1600	Woodman *et al.* (1997)
OxA-5740	Castlepook Cave; phalanx: giant deer, Gallery of Aged Carnivores	37,200 ± 2000	Woodman *et al.* (1997)
OxA-3701	Catacomb, Co. Clare, Ireland; radius: reindeer, upper stratum	10,850 ± 80	Woodman *et al.* (1997)
OxA-3723	Catacomb; humerus: giant deer, 1st stratum	11,750 ± 90	Woodman *et al* (1997)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-3709	Cave N, Co. Sligo, Ireland; mandible: Arctic lemming, 4th layer	10,060 ± 100	Woodman *et al.* (1997)
BM-731	Charterhouse Warren Farm Swallet, Somerset; radius: aurochs	3,245 ± 37	Clutton-Brock (1986)
OxA-1781	Chelm's Combe, Somerset; metacarpal: reindeer, 7	10,600 ± 200	AM 10
OxA-1782	Chelm's Combe; mandibular ramus: reindeer, 9	10,140 ± 100	AM 10
OxA-1783	Chelm's Combe; mandibular ramus: red deer, 9	10,910 ± 110	AM 10
OxA-1784	Chelm's Combe; mandibular ramus: reindeer, 12	10,230 ± 110	AM 10
BM-2318	Chelm's Combe; metapodial: reindeer, Area A/spit 7	10,190 ± 130	Burleigh (1986)
BM-2431	Chelm's Combe; tibia: reindeer, Area A/spit 7	10,220 ± 130	Burleigh (1986)
BM-447	Cherhill, Wiltshire; bone, tufa level	7,230 ± 140	Grigson (1978)
BM-493	Cherhill; occupation beneath colluvium	4,706 ± 90	Cunliffe (1993)
OxA-735	Church Hole Cave, Nottinghamshire; mountain hare	12,240 ± 150	AM 4
OxA-3717	Church Hole Cave; antler rod: reindeer	12,020 ± 100	AM 18
OxA-3718	Church Hole Cave; antler rod: reindeer	12,250 ± 90	AM 18
OxA-4108	Church Hole Cave; Arctic hare	12,110 ± 120	AM 18
OxA-5799	Church Hole Cave; tooth: hyaena	26,840 ± 420	AM 22
OxA-5800	Church Hole Cave; tooth: hyaena	24,000 ± 260	AM 22
OxA-5738	Coffey Cave, Co. Sligo, Ireland; mandible: stoat, 2nd stratum	7,650 ± 130	Woodman *et al.* (1997)
Birm-1273a	Condover, Shropshire; mammoth	12,720 ± 180	Lister (1991)
OxA-1021	Condover; tusk: mammoth	12,700 ± 160	AM 7 & AM9; Lister (1991)
Birm-1283	Condover; mammoth	12,610 ± 220	Lister (1991)
OxA-1455	Condover; tusk: mammoth	12,400 ± 160	AM 9; Lister (1991)
OxA-1456	Condover; tooth: mammoth	12,330 ± 120	AM 9; Lister (1991)
OxA-1316	Condover; tooth: mammoth	12,300 ± 180	AM 9; Lister (1991)
OxA-1457	Condover; puparia: insect, from inside juvenile	12,080 ±130	AM 9
OxA-1591	Condover; dung beetles	11,880 ± 130	AM 9
OxA-1610	Conningbrook Pit, Kent; bone: mammoth	35,200 ± 1600	AM 9; Lister (1991)
OxA-1611	Conningbrook Pit; bone: mammoth	38,600 ± 2400	AM 9; Lister (1991)
OxA-1069	Conningbrook Pit; bone: mammoth	33,200 ± 1300	AM 9
OxA-1612	Conningbrook Pit; bone: woolly rhino	34,000 ± 1400	AM 9
OxA-1613	Conningbrook Pit; bone. woolly rhino	35,000 ± 1500	AM 9
OxA-1644	Conningbrook Pit; bone: mammoth	37,300 ± 1900	AM 9
OxA-1645	Conningbrook Pit; bone: woolly rhino	33,600 ± 1200	AM 9
BM-499	Coygan Cave, Dyfed, Wales; antler: reindeer, artefact level	38,684 +2713/-2024	Green & Walker (1991)
OxA-2509	Coygan Cave; bone: woolly rhino, overlaying artefact level	24,620 ± 320	AM 18; Green & Walker (1991)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
BM-1674	*Darent River Gravels, Kent; reindeer*	9,760 ± 70	*RC9*
BM-1674R	Darent River Gravels [recalculated date]	10,080 ± 120	RC16
BM-1675	*Darent River Gravels; antler frag: fallow deer, HZM2.9766*	150 ± 60	*RC9*
BM-1675R	Darent River Gravels [recalculated date]	510 ± 110	RC16
BM-440A	Dead Man's Cave, S. Yorkshire; bone: incl. reindeer, basal sand LSB	9,940 ± 115	Campbell (1977)
BM-439	Dead Man's Cave; bone: incl. reindeer, basal sand LSB	9,850 ± 115	Campbell (1977)
BM-440B	Dead Man's Cave; antler: reindeer, ?basal sand LSB	9,750 ± 110	Campbell (1977)
OxA-5804	Dead Man's Cave; phalange: reindeer	10,020 ± 80	AM 22
HAR-4309	Dog Hole Fissure, Derbyshire; mixed species, spits 8-16, strat layer 3	9,960 ± 140	Jenkinson (1984)
OxA-1463	Dowel Cave, Derbyshire; antler tang: cervid	11,200 ± 120	AM 9
OxA-2071	Drayton Cursus, Oxfordshire; waterlogged and singed bark	4,810 ± 70	AM 11
OxA-2073	Drayton Cursus; wood charcoal and *Corylus* nut frags	4,800 ± 100	AM 11
OxA-2074	Drayton Cursus; pomoideae charcoal	4,620 ± 80	AM 11
OxA-2075	Drayton Cursus; charcoal incl. root wood: *Quercus*	4,940 ± 80	AM 11
OxA-2076	Drayton Cursus; charcoal incl. root wood: *Quercus*	4,220 ± 80	AM 11
OxA-2078	Drayton Cursus; charcoal incl. root wood: *Quercus*	3,880 ± 70	AM 11
OxA-2072	Drayton Cursus; charred nut frags: *Corylus*	3,630 ± 80	AM 11
HAR-6478	Drayton Cursus; bone: mixed species, cursus ditch: primary silt	4,780 ± 100	RC21; Ainslie & Wallis (1987)
BM-395	Durrington Walls, Wiltshire; antler: cervid, post-hole 92	3,900 ± 90	Wainwright & Longworth (1971);Cunliffe (1993)
BM-396	Durrington Walls; charcoal, post-hole 92	3,950 ± 90	Wainwright & Longworth (1971);Cunliffe (1993)
BM-397	Durrington Walls; bone, post-hole 92	3,850 ± 90	Wainwright & Longworth (1971);Cunliffe (1993)
BM-398	Durrington Walls; charcoal, base of ditch	3,927 ± 90	Wainwright & Longworth (1971);Cunliffe (1993)
BM-399	Durrington Walls; bone, base of ditch	3,965 ± 90	Wainwright & Longworth (1971);Cunliffe (1993)
BM-400	Durrington Walls; antler: cervid, base of ditch	4,000 ± 90	Wainwright & Longworth (1971);Cunliffe (1993)
NPL-239	Durrington Walls	3,760 ± 140	Wainwright & Longworth (1971)
NPL-192	Durrington Walls; midden	4,270 ± 95	Cunliffe (1993)
NPL-240	Durrington Walls; post-hole: north circle	3,905 ± 110	Cunliffe (1993)
BM-286	Durrington Walls; hearth on primary silt	3,630 ± 110	Cunliffe (1993)
BM-285	Durrington Walls; hearth on secondary silt- above primary silt	3,560 ± 120	Cunliffe (1993)
GRO-901	Durrington Walls; charcoal, beneath henge	4,584 ± 80	Cunliffe (1993)
GRO-901a	Durrington Walls; charcoal, beneath henge	4,575 ± 50	Cunliffe (1993)
NPL-191	Durrington Walls; charcoal, beneath henge	4,440 ± 150	Cunliffe (1993)
OxA-3761	Easton Down Long Barrow, Wiltshire; tooth: *Bos*	3,860 ± 60	Whittle *et al.* (1993)
OxA-811	Elderbush Cave, Staffordshire; vertebra+ cut ribs· cervid (?reindeer)	10,600 ± 110	AM 4

Radiocarbon Dates for Non-horse Material from British and Irish Sites: with specimen and stratigraphy information

Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-812	Elderbush Cave; charcoal	9,000 ± 130	AM 4
OxA-3724	Elderbush Cave Newhall, Co. Clare, Ireland; radius: wolf	1,730 ± 60	Woodman *et al.* (1997)
OxA-1311	Etton, Cambridgeshire, antler: red deer, (1948.1)	3,080 ± 80	AM 21
OxA-1312	Etton, Cambridgeshire; antler: red deer, (1948.2)	3,020 ± 60	AM 21
BM-1735	*Feltwell Fen, Norfolk; radius ulna: reindeer*	11,560 ± 110	*RC9*
BM-1735R	Feltwell Fen [recalculated date]	11,600 ± 140	RC16
HAR-398	Fengate Sites (Storey's Bar Road), Cambridgeshire; twigs	3,000 ± 70	Pryor (1978)
Q-66	Flixton Site II, N. Yorkshire; organic mud	10,413 ± 210	RC34
OxA-8103	Formby Point, Merseyside; bone: *Bos* sp., 17	154.4 ± 1.2	S. Stallibrass & P. Rowley-Conwy (pers. comm.)
OxA-1494	Fox Hole Cave, Derbyshire; antler rod/point: ?red deer, "Bear Chamber"	12,000 ± 120	AM 9
OxA-1493	Fox Hole Cave; antler rod: reindeer, "1st Chamber"	11,970 ± 120	AM 9
BM-134	Fussell's Lodge, Wiltshire; charcoal	5,180 ± 150	RC4
BM-191	Giant's Hills, Lincolnshire	4,410 ± 150	Neil (1977)
BM-192	Giant's Hills	4,320 ± 150	Neil (1977)
OxA-1202	Gough's (New) Cave, Somerset; humerus: human, IA.1/8	2,850 ± 60	AM 7
OxA-814	Gough's (New) Cave; talus of 'Cheddar Man': human	9,100 ± 100	AM 4
OxA-1890	Gough's (New) Cave; 'new' ivory rod	12,170 ± 130	AM 10
OxA-463	Gough's (New) Cave; calcaneum: saiga antelope, spit 14	12,380 ± 160	AM 2
OxA-466	Gough's (New) Cave; modified metapodial: red deer, spit 13	12,800 ± 170	AM 2
OxA-813	Gough's (New) Cave; astragalus: aurochs	11,900 ± 140	AM 4
OxA-1071	Gough's (New) Cave; cut phal II: red deer, spit 11	12,300 ± 180	AM 6
OxA-1200	Gough's (New) Cave; partial mandible: Arctic fox	12,400 ± 110	AM 7
OxA-1461	Gough's (New) Cave; maxilla: reindeer, M.49863	10,450 ± 110	AM 10
OxA-3411	Gough's (New) Cave; femur: northern lynx, GC 86/27A, Area 1	12,650 ± 120	AM 18
OxA-3412	Gough's (New) Cave; tibia: red deer, GC 86 1, Area 1	12,490 ± 120	AM 18
OxA-3414	Gough's (New) Cave; partial rib, GC1990, E2/184, area III	12,570 ± 120	AM 18
OxA-4107	Gough's (New) Cave; pointed tibia: Arctic hare, GC 89/68, area I	12,550 ± 130	AM 18
BM-525	Gough's (New) Cave; tibia: human, 'Cheddar Man' (GC1)	9,080 ± 150	RC6
Q-1581	Gough's (New) Cave; antler frag: reindeer, spit 8	9,920 ± 130	Clutton-Brock & Burleigh (1983)
OxA-815	Gough's (New) Cave; maxilla: *Sus scrofa*, spit 12	1,740 ± 60	Burleigh (1986)
OxA-2797	Gough's (New) Cave; antler baton: reindeer, GC 89/99	11,870 ± 110	AM 13
OxA-2234	Gough's (New) Cave; bone: human, GC2	11,480 ± 90	Cunliffe (1993)
OxA-2795	Gough's (New) Cave; bone: human, GC87/169	11,820 ± 120	Cunliffe (1993)
OxA-2235	Gough's (New) Cave; bone: human, GC3	11,990 ± 90	Cunliffe (1993)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-2236	Gough's (New) Cave; bone: human, GC6	11,700 ± 100	Cunliffe (1993)
OxA-2237	Gough's (New) Cave; bone: human, M23	12,300 ± 100	Cunliffe (1993)
OxA-2796	Gough's (New) Cave; bone: human, GC87/190	12,380 ± 110	Cunliffe (1993)
OxA-1119	Gough's (Old) Cave, Somerset; mandibular ramus: beaver	9,320 ± 120	AM 6
OxA-1120	Gough's (Old) Cave; antler: reindeer	10,190 ± 120	AM 6
OxA-588	Gough's (Old) Cave; frags: bovine, ?spit 15	12,030 ± 150	AM 3
AA-18510	Green Craig, Lothian, Scotland; tibia: reindeer, NMSZ 1993.192.11	9,710 ± 80	Kitchener & Bonsall (1997)
NPL-76	Hambledon Hill, Dorset	4,740 ± 90	Cunl ffe (1993)
HAR-2041	Hambledon Hill	4,110 ± 80	Cunliffe (1993)
HAR-1886	Hambledon Hill	4,840 ± 150	Cunliffe (1993)
HAR-1882	Hambledon Hill	4,560 ± 90	Cunliffe (1993)
HAR-2375	Hambledon Hill	4,670 ± 100	Cunliffe (1993)
HAR-1885	Hambledon Hill	4,480 ± 130	Cunliffe (1993)
HAR-2371	Hambledon Hill	4,680 ± 110	Cunliffe (1993)
HAR-2377	Hambledon Hill	4,610 ± 90	Cunliffe (1993)
HAR-2378	Hambledon Hill	4,820 ± 120	Cunliffe (1993)
HAR-2379	Hambledon Hill	4,350 ± 80	Cunliffe (1993)
HAR-2372	Hambledon Hill	4,630 ± 80	Cunliffe (1993)
BM-1585	Hemp Knoll, Wiltshire; scapula: aurochs	3,760 ± 60	Clutton-Brock (1986)
HAR-2997	Hemp Knoll; occupation	4,580 ± 80	Cunliffe (1993)
OxA-1024	Hoyle's Mouth, Dyfed; indet. bone, layer 3A (entrance chamber)	27,900 ± 600	Green & Walker (1991)
OxA-3277	Hyaena Den, Somerset; charred bone, HDT	33,660 ± 680	AM 22
OxA-3451	Hyaena Den; bone antler point, 1484	24,600 ± 300	AM 22
OxA-4111	Hyaena Den; charred bone, HDT	28,000 ± 500	AM 22
OxA-4112	Hyaena Den; charred bone, HDH	27,850 ± 460	AM 22
OxA-4113	Hyaena Den; charred bone, HDH	34,900 ± 1450	AM 22
OxA-4782	Hyaena Den; cut incisor: red deer, HDH	40,400 ± 1600	AM 22
OxA-5700	Hyaena Den; phal I: red deer, UHD, breccia	11,320 ± 120	AM 22
OxA-5701	Hyaena Den; antler, UHDNW	31,450 ± 550	AM 22
OxA-5702	Hyaena Den; canine: bear, UHDNW	32,750 ± 700	AM 22
OxA-5704	Hyaena Den; canine: wolf, HDHS	39,100 ± 1300	AM 22
OxA-5805	Hyaena Den; antler: reindeer, UHDNW (take as minimum age)	24,560 ± 340	AM 22
OxA-6114	Kendrick's Cave, Gwynedd, Wales; femur: human, no.60	12,090 ± 90	J. Cook (pers. comm.)
OxA-6145	Kendrick's Cave; femur: human, no 58	5,140 ± 65	J. Cook (pers. comm.)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-6116	Kendrick's Cave; incised metacarpal, no.31	11,795 ± 65	J. Cook (pers. comm.)
OxA-5862	Kendrick's Cave; decorated tooth: badger	9,945 ± 75	J. Cook (pers. comm.)
OxA-6146	Kendrick's Cave; tibia: bovid, no.18	12,410 ± 100	J. Cook (pers. comm.)
OxA-7002	Kendrick's Cave; human, no.69	11,760 ± 90	J. Cook (pers. comm.)
OxA-7003	Kendrick's Cave; human, no.57	11,880 ± 90	J. Cook (pers. comm.)
OxA-7004	Kendrick's Cave; human, no.59	11,930 ± 90	J. Cook (pers. comm.)
OxA-1787	Kent's Cavern, Devon; cranium: human	3,560 ± 70	AM 9
OxA-1786	Kent's Cavern; maxilla: human	8,070 ± 90	AM 9
OxA-1621	Kent's Cavern; maxilla: human	30,900 ± 900	AM 9
OxA-1789	Kent's Cavern; bone piercer, Pengelly #1835 "Black Band"	12,320 ± 130	AM 9
OxA-1203	Kent's Cavern; partial mandible: aurochs, Black Band	11,880 ± 120	AM 7
OxA-1029	Kent's Cavern; elk, I(a)1	31,100 ± 800	AM 6
OxA-2845	*Kent's Cavern; bone pin, #1929:E.86, cave earth 4th ft. spit*	14,140 ± 110	*AM 18*
OxA-2155	Kent's Cavern; ivory rod, Pengelly #1963, Black band	11,650 ± 130	AM 13
GrN-6203	Kent's Cavern; bone: brown bear, "cave earth" Bl.Band B2 Vestibule	14,275 ± 120	AM 7; Campbell (1977)
GrN-6204	Kent's Cavern; bone: giant deer, "cave earth" B2 Vestibule	12,180 ± 100	Campbell (1977)
BM-2168	*Kent's Cavern; atlas frag: bovid, M.559 Pengelly #1951 Black Band*	11,570 ± 410	*RC12*
BM-2168R	Kent's Cavern [recalculated date]	11,800 ± 420	RC16
GrN-6325	Kent's Cavern; bone: *Bison* sp., "cave earth" A2, Great Chamber	27,730 ± 350	Campbell (1977)
GrN-6202	Kent's Cavern; bone: brown bear, "cave earth" A2 Gallery	28,720 ± 450	Campbell (1977)
GrN-6201	Kent's Cavern; bone: woolly rhino, "cave earth" A2 Great Chamber	28,160 ± 435	Campbell (1977)
OxA-3449	Kent's Cavern; metapodial: woolly rhino, Vestibule	34,500 ± 800	AM 22
OxA-3450	Kent's Cavern; metapodial: woolly rhino, Vestibule	34,620 ± 820	AM 22
OxA-4435	Kent's Cavern; tooth: red deer, Vestibule	28,060 ± 440	AM 22
OxA-4436	Kent's Cavern; mandible: reindeer, Vestibule	27,780 ± 400	AM 22
OxA-4437	Kent's Cavern; mandible: fox, Vestibule (take as minimum age)	23,680 ± 300	AM 22
OxA-4438	Kent's Cavern; mandible: fox, Vestibule (take as minimum age)	28,700 ± 600	AM 22
OxA-5693	Kent's Cavern; calcaneum: reindeer, Vestibule	27,820 ± 500	AM 22
OxA-5694	Kent's Cavern; calcaneum: reindeer, Vestibule	28,880 ± 440	AM 22
OxA-5695	Kent's Cavern; scapula: wolf, Vestibule	26,300 ± 340	AM 22
OxA-5696	Kent's Cavern; femur: giant deer, Vestibule (take as minimum age)	23,080 ± 260	AM 22
OxA-6108	Kent's Cavern; nasal bone: woolly rhino, Vestibule	30,220 ± 460	AM 22
OxA-5697	Kent's Cavern; charcoal, 5961, 48/4/gran.Stal., Long Arcade	3,600 ± 80	AM 22
Pta-2378	Kilgreany Cave, Co. Waterford, Ireland; bone: reindeer	10,700 ± 100	Woodman *et al.* (1997)

Radiocarbon Dates for Non-horse Material from British and Irish Sites: with specimen and stratigraphy information

Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
BM-135	Kilgreany Cave; human, A	4,580 ± 150	Woodman *et al.* (1997)
Pta-2644	Kilgreany Cave; human, B	4,820 ± 60	Woodman *et al.* (1997)
OxA-4239	Kilgreany Cave; mandibles: Arctic lemming	10,360 ± 120	Woodman *et al.* (1997)
OxA-4240	Kilgreany Cave; vertebra: reindeer	10,990 ± 120	Woodman *et al.* (1997)
OxA-4241	Kilgreany Cave; phal II: giant deer	10,960 ± 110	Woodman *et al.* (1997)
OxA-4242	Kilgreany Cave; metapodial: wild pig	8,340 ± 110	Woodman *et al.* (1997)
OxA-4269	Kilgreany Cave; tibia: cattle (*Bos taurus*)	5,190 ± 80	Woodman *et al.* (1997)
OxA-5732	Kilgreany Cave; skull: stoat	9,980 ± 90	Woodman *et al.* (1997)
OxA-5733	Kilgreany Cave; femur: lynx	8,875 ± 70	Woodman *et al.* (1997)
OxA-5734	Kilgreany Cave; mandible: cattle (*Bos taurus*)	1,515 ± 55	Woodman *et al.* (1997)
OxA-5735	Kilgreany Cave; tooth: pine marten	2,780 ± 55	Woodman *et al.* (1997)
OxA-4605	Killuragh Cave, Co. Limerick, Ireland; phalanx: giant deer	11,510 ± 100	Woodman *et al.* (1997)
OxA-611	Killuragh Cave; metatarsus: red deer	955 ± 50	Woodman *et al.* (1997)
OxA-1562	King Arthur's Cave, Hereford & Worcester; tooth: red deer, Yellow Rubble (Lower 1/2)	12,120 ± 120	AM 9
OxA-1563	King Arthur's Cave, Hereford & Worcester; tooth: red deer, 2nd Hearth	12,210 ± 120	AM 9
OxA-1564	King Arthur's Cave; tooth: mammoth, Mammoth layer	34,850 ± 1500	AM 9
OxA-1565	King Arthur's Cave; tooth: mammoth, Red Clay	38,500 ± 2300	AM 9
OxA-1566	King Arthur's Cave; tooth: mammoth, Red Clay	>39,500	AM 9
OxA-5863	King Arthur's Cave; phalanx: human	4,670 ± 60	AM 24
OxA-2456	Kinsey Cave, N. Yorkshire; antler artefact: reindeer	11,270 ± 110	AM 14
BM-2620	Kirkburn, Humberside; bone: human, Neolithic enclosure	3,370 ± 50	RC17
BM-1707	*Lingey Fen, Cambridgeshire; aurochs*	4,630 ± 50	*RC9*
BM-1707R	Lingey Fen [recalculated date]	4,860 ± 110	RC16
BM-1711B	*Lingey Fen*	2,560 ± 45	*RC9*
BM-1711BR	Lingey Fen; [recalculated date]	2,780 ± 110	RC16
BM 1708	*Lingey Fen; aurochs*	6,370 ± 70	*RC9*
BM-1708R	Lingey Fen [recalculated date]	6,600 ± 120	RC16
BM-1711A	*Lingey Fen; red deer*	2,620 ± 40	*RC9*
BM-1711AR	Lingey Fen [recalculated date]	2,850 ± 110	RC16
OxA-1576	Maiden Castle, Dorset; lumbar vertebra: *Bos*, Trench III, 14589, 1985-86 excavs	4,790 ± 100	AM 9; Ambers *et al.* (1991)
OxA-1144	Maiden Castle; thoracic vertebra: lg. ungulate, Trench II, 14563, 1985-86 excavs	4,550 ± 80	AM 8; Ambers *et al.* (1991)
OxA-1148	Maiden Castle; bone: human, Trench I, 14577, 1985-86 excavs	4,810 ± 80	AM 8; Ambers *et al.* (1991)
OxA-1337	Maiden Castle; humerus: *Sus*, Trench II, 14557, 1985-86 excavs	5,030 ± 80	AM 8, Ambers *et al.* (1991)
BM-2447	Maiden Castle; bone: lg. ungulate, ref 14555 colld. 1985	4,800 ± 45	RC15; Ambers *et al.* (1991)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
BM-2448	Maiden Castle; tibia: ox, ref.14558, colld. 1985	4,710 ± 70	RC15; Ambers *et al.* (1991)
BM-2449	Maiden Castle, charcoal: *Quercus* sp., colld. 1985	5,040 ± 60	RC15; Ambers *et al.* (1991)
BM-2451	Maiden Castle; femur: human, ref.2010 colld 1985	4,860 ± 70	RC15; Ambers *et al.* (1991)
BM-2456	Maiden Castle; tibia: red deer, ref.14543 colld. 1985	4,720 ± 100	RC15; Ambers *et al.* (1991)
BM-2455	Maiden Castle; femur: ox, ref.14570, assoc.with Beaker pottery, colld.1985	3,470 ± 70	RC15; Ambers *et al.* (1991)
BM-2450	Maiden Castle; charcoal, enclosure ditches, inner primary fill	5,030 ± 40	Ambers *et al.* (1991)
BM-2454	Maiden Castle; animal bone, enclosure ditches, inner secondary fill	4,830 ± 60	Ambers *et al.* (1991)
OxA-1143	Maiden Castle; animal bone, enclosure ditches, inner secondary fill	4,730 ± 80	Ambers *et al.* (1991)
OxA-1147	Maiden Castle; animal bone, enclosure ditches, inner secondary fill	4,690 ± 80	Ambers *et al.* (1991)
OxA-1338	Maiden Castle; animal bone, enclosure ditches, outer primary fill	4,930 ± 90	Ambers *et al.* (1991)
OxA-1339	Maiden Castle; animal bone, enclosure ditches, outer primary fill	4,740 ± 80	Ambers *et al.* (1991)
OxA-1340	Maiden Castle; animal bone, enclosure ditches, outer primary fill	4,650 ± 70	Ambers *et al.* (1991)
BM-2452	Maiden Castle; animal bone, enclosure ditches, outer primary fill	4,640 ± 50	Ambers *et al.* (1991)
OxA-1146	Maiden Castle; animal bone, Bank Barrow ditch, primary fill	4,650 ± 80	Ambers *et al.* (1991)
OxA-1145	Maiden Castle; antler: cervid, Bank Barrow ditch, pits cut into primary fill	4,660 ± 80	Ambers *et al.* (1991)
OxA-1349	Maiden Castle; antler: cervid, Bank Barrow ditch, pits cut into primary fill	4,660 ± 80	Ambers *et al.* (1991)
BM-2453	Maiden Castle; charcoal, Bank Barrow ditch, bank between ditches	14,310 ± 100	Ambers *et al.* (1991)
OxA-1336	Maiden Castle; animal bone, Bank Barrow ditch, bank between ditches	4,570 ± 80	Ambers *et al.* (1991)
OxA-1142	Maiden Castle; animal bone, Enclosure ditch, inner final fill	4,750 ± 80	Ambers *et al.* (1991)
OxA-1141	Maiden Castle; animal bone, Enclosure ditch, inner final fill	4,360 ± 80	Ambers *et al.* (1991)
OxA-1341	Maiden Castle; charcoal, Bank Barrow ditch, final fill	4,460 ± 80	Ambers *et al.* (1991)
BM-557	Marden Henge, Wiltshire; charcoal, base of enclosure ditch primary ditch silt	3,938 ± 48	Neil (1977); Cunliffe (1993)
BM-558	Marden Henge; animal bone, base of enclosure ditch: primary ditch silt	3,526 ± 99	Neil (1977); Cunliffe (1993)
BM-559	Marden Henge; antler, base of enclosure ditch: primary ditch silt	3,626 ± 81	Neil (1977); Cunliffe (1993)
BM-560	Marden Henge; charcoal, buried turf line: beneath henge (?contaminated)	4,604 ± 59	Neil (1977); Cunliffe (1993)
OxA-516	Merlin's Cave, Hereford & Worcester; x2 mandib es: pika	10,020 ± 120	AM 3
OxA-3169	Millbarrow Chambered Tomb, Wiltshire; jaw: human	4,620 ± 90	AM 14
OxA-3170	Millbarrow Chambered Tomb; antler: red deer	4,630 ± 100	AM 14
OxA-3171	Millbarrow Chambered Tomb; jaw: human	4,750 ± 120	AM 14
OxA-3172	Millbarrow Chambered Tomb; jaw: human	4,900 ± 110	AM 14
OxA-3198	Millbarrow Chambered Tomb; jaw: human	4,480 ± 80	AM 14
BM-2729	Millbarrow Chambered Tomb; conventional samples	4,450 ± 50	AM 14
BM-2730	Millbarrow Chambered Tomb; conventional samples	4,560 ± 70	AM 14
BM-2731	Millbarrow Chambered Tomb; conventional samples	4,560 ± 50	AM 14

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
HAR-6471	Milton Lilbourne, Wiltshire; Barrow 1, SE grave	3,400 ± 100	Cunliffe (1993)
HAR-6456	Milton Lilbourne; Barrow 2, loam core	3,420 ± 80	Cunliffe (1993)
HAR-6472	Milton Lilbourne; Barrow 2, loam core	3,590 ± 190	Cunliffe (1993)
HAR-6455	Milton Lilbourne; Barrow 4, loam core	3,380 ± 80	Cunliffe (1993)
HAR-6453	Milton Lilbourne; charcoal, Barrow 4, charcoal spread	3,580 ± 80	Cunliffe (1993)
HAR-6454	Milton Lilbourne; Barrow 4, timber baulk	3,780 ± 80	Cunliffe (1993)
HAR-6457	Milton Lilbourne; Barrow 4, timber baulk	3,590 ± 90	Cunliffe (1993)
HAR-6458	Milton Lilbourne; Barrow 4, timber baulk	3,460 ± 80	Cunliffe (1993)
HAR-6470	Milton Lilbourne; charcoal, Barrow 5, charcoal from ditch	3,410 ± 80	Cunliffe (1993)
OxA-733	Mother Grundy's Parlour, Derbyshire; bone: *cf* bovid, LL7370	12,060 ± 160	AM 4
OxA-734	Mother Grundy's Parlour; *cf* bovid, LL7371	12,190 ± 140	AM 4
Q-1438	Mother Grundy's Parlour; bulked bone frags	11,285 ± 180	Jacobi (1980)
Q-1459	Mother Grundy's Parlour; bulked bone frags	11,160 ± 170	Jacobi (1980)
No number	Mother Grundy's Parlour; *Bos* frag, Upper Base Zone	11,320 ±230	Jacobi (1980)
Q-1483	Mother Grundy's Parlour; *Bos* frag, Hearth	11,070 ± 170	Jacobi (1980)
Q 551	Mother Grundy's Parlour; charcoal & *Corylus* shells, sharp scree SB	8,800 ± 300	RC35; Campbell (1977)
Q-552	Mother Grundy's Parlour, charcoal & *Corylus* shells, interface C/B	7,602 ± 140	RC35; Campbell (1977)
Q-553 4	Mother Grundy's Parlour; baulked organic, layer C	6,760 ± 140	Campbell (1977)
OxA-3453	Mother Grundy's Parlour; rib w/ embedded flint: lg. mammal, spit 12 layer B, E-F II-IV	8,960 ± 95	AM 18
OxA-3399	Mother Grundy's Parlour; upper premolar: bovid, spit 9 Layer B	9,910 ± 90	AM 18
OxA-3395	Mother Grundy's Parlour; charred phalange: bovid, spit 4 lower 1/2 C	8,480 ± 95	AM 18
OxA-3392	Mother Grundy's Parlour; charcoal: *Taxus*, F IV, B/C	4,110 ± 75	AM 18
OxA-3394	Mother Grundy's Parlour; charred nut shells: *Corylus*, E IV, B	8,730 ± 95	AM 18
OxA-3396	Mother Grundy's Parlour; charred nut shells: *Corylus*, E-F XIV-XIV, C	8,500 ± 110	AM 18
OxA-3397	Mother Grundy's Parlour; charred nut shells: *Corylus*, E IV, B/C	8,900 ± 90	AM 18
OxA-4442	Mother Grundy's Parlour; tooth: human, E+F II, spit I, McBurney	3,720 ± 80	AM 22
OxA-5858	Mother Grundy's Parlour; charcoal: indet.sp., from a fire-pit, Armstrong	11,790 ± 90	AM 22
BM-644	Mount Pleasant, Dorset; charcoal, pre-enclosure settlement	4,072 ± 73	Wainwright (1979a)
BM-645	Mount Pleasant; antler: cervid, enclosure ditch: west entrance, primary (II 8 DTS)	3,734 ± 41	Wainwright (1979a)
BM-646	Mount Pleasant; antler: cervid, enclosure ditch: west entrance, primary (II 8 DTN)	3,728 ± 59	Wainwright (1979a)
BM-664	Mount Pleasant; charcoal, enclosure ditch: west entrance, secondary (II DTPN 3)	3,410 ± 131	Wainwright (1979a)
BM-788	Mount Pleasant; charcoal, enclosure ditch: north entrance (XXIX/XXVIII 6)	3,506 ± 55	Wainwright (1979a)
BM-789	Mount Pleasant; charcoal, enclosure ditch: north entrance (XXIX 7)	3,459 ± 53	Wainwright (1979a)
BM-790	Mount Pleasant; charcoal, enclosure ditch: north entrance (XXVIII/XXIX 8)	3,619 ± 55	Wainwright (1979a)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
BM-791	Mount Pleasant; charcoal, enclosure ditch: north entrance (XXIX 10)	3,891 ± 66	Wainwright (1979a)
BM-792	Mount Pleasant; charcoal, enclosure ditch: north entrance (XXVIII/XXIX 11)	4,058 ± 71	Wainwright (1979a)
BM-793	Mount Pleasant; charcoal, enclosure ditch: north entrance (XXIX 12)	4,048 ± 54	Wainwright (1979a)
BM-663	Mount Pleasant; charcoal, timber structure: site IV, primary (Seg. VII 10)	3,911 ± 89	Wainwright (1979a)
BM-666	Mount Pleasant; antler: cervid, timber structure: site IV, primary (Seg. VII 10)	3,941 ± 72	Wainwright (1979a)
BM-667	Mount Pleasant; antler: cervid, timber structure: site IV, primary (Seg. VII 10)	3,988 ± 84	Wainwright (1979a)
BM-668	Mount Pleasant; charcoal, timber structure: site IV, secondary (Seg. X 5)	3,630 ± 60	Wainwright (1979a)
BM-669	Mount Pleasant; charcoal, timber structure: site IV, tertiary (Seg. VIII alpha 5)	3,274 ± 51	Wainwright (1979a)
BM-662	Mount Pleasant; antler: cervid, palisade trench (construction)	3,637 ± 63	Wainwright (1979a)
BM-665	Mount Pleasant; charcoal, palisade trench (construction)	3,645 ± 43	Wainwright (1979a)
BM-794	Mount Pleasant; animal bone, palisade trench (pit XVII)	3,956 ± 45	Wainwright (1979a)
BM-795	Mount Pleasant; antler: cervid, conquer barrow ditch (XLVI)	4,077 ± 52	Wainwright (1979a)
UB-2392	Newgrange, Co. Meath, Ireland; charcoal, from settlement area	3,985 ± 55	Wijngaarden-Bakker (1986)
UB-2393	Newgrange; charcoal, from settlement area	3,985 ± 45	Wijngaarden-Bakker (1986)
UB-2394	Newgrange; charcoal, from settlement area	3,875 ± 90	Wijngaarden-Bakker (1986)
GrN-5462	*Newgrange; building of passage grave*	4,200 ± 45	*Wijngaarden-Bakker (1974)*
GrN-5462c	Newgrange; building of passage grave	4,425 ± 45	Wijngaarden-Bakker (1974)
GrN-5463	Newgrange; building of passage grave	4,415 ± 40	Wijngaarden-Bakker (1974)
UB-361	Newgrange; building of passage grave	4,335 ± 105	Wijngaarden-Bakker (1974)
GrN-6342	Newgrange; Beaker settlement, same horizon as horse metapodials	3,885 ± 35	Wijngaarden-Bakker (1974)
GrN-6343	Newgrange; Beaker settlement	3,990 ± 40	Wijngaarden-Bakker (1974)
GrN-6344	Newgrange; Beaker settlement	4,050 ± 40	Wijngaarden-Bakker (1974)
BM-49	Nutbane, Hampshire; charcoal, from forecourt	4,680 ± 150	Cunliffe (1993)
OxA-630	Ossom's Cave, Staffordshire; proximal ulna: human, O.VIII.3	4,860 ± 80	AM 3
OxA-631	Ossom's Cave; mandible: reindeer, depth 56" w/in sed.C areaV	10,780 ± 160	AM 3
OxA-632	Ossom's Cave; antler 'spike': reindeer, 66-72" w/in sed.C area VI	10,600 ± 140	AM 3
GrN-7400	Ossom's Cave; bone reindeer, same horizon as horse (Layer C)	10,590 ± 70	Bramwell *et al.* (1987)
BM-2127	*Ossom's Cave; limb bone frag: ?reindeer, V.C.red clay*	11,930 ± 310	*RC11; Campbell (1977)*
BM-2127R	Ossom's Cave [recalculated date]	12,220 ± 320	RC16
BM-2126	*Ossom's Cave; frag of bone shaft bovid(lg.), (ref sample c) Layer D, V VI*	25,300 ± 1500	*RC11; Bramwell et al. (1987)*
BM-2126R	Ossom's Cave [recalculated date]	25,610 ± 1500	RC16
BM-2128	*Ossom's Cave; femur frag: indet. sp., O.VIII.3*	4,810 ± 420	*RC11*
BM-2128R	Ossom's Cave [recalculated date]	5,120 ± 430	RC16
OxA-629	Ossom's Cave; tibia frag: ?bovine, O.VI.C 4'-4'6"	2,030 ± 80	Bramwell *et al.* (1987)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-1204	Pin Hole Cave, Derbyshire; calcaneum: mammoth	12,460 ± 160	AM 7; Lister (1991)
OxA-1469	Pin Hole Cave; cut radius: pig	3,750 ± 80	AM 9
OxA-1205	Pin Hole Cave; cuneiform: mammoth	26,700 ± 550	AM 7
OxA-1936	Pin Hole Cave, antler: reindeer	13,050 ± 250	AM 9
OxA-1470	Pin Hole Cave; antler: reindeer	38,000 ± 2000	AM 9
OxA-1466	Pin Hole Cave; tibia: mountain hare	10,950 ± 120	AM 9
OxA-1467	Pin Hole Cave; cut radius: mountain hare	12,350 ± 120	AM 9
OxA-1468	Pin Hole Cave; humerus: mountain hare	14,010 ± 150	AM 9
OxA-1471	Pin Hole Cave; astragalus: aurochs	12,400 ± 140	AM 9
OxA-1615	Pin Hole Cave; astragalus: aurochs	12,480 ± 160	AM 9
OxA-1937	Pin Hole Cave; tibia: aurochs	10,970 ± 110	AM 9
OxA-1806	Pin Hole Cave; scapula: lion	27,400 ± 700	AM 9
OxA-1614	Pin Hole Cave; tooth: woolly rhino	22,500 ± 700	AM 9
OxA-1813	Pin Hole Cave; ulna: woolly rhino	>41,400	AM 9
OxA-1206	Pin Hole Cave; metacarpal: hyaena	32,200 ± 1000	AM 7
OxA-1207	Pin Hole Cave; metacarpal: hyaena	34,500 ± 1200	AM 7
OxA-1448	Pin Hole Cave; mandible: hyaena	42,200 ± 3000	AM 9
OxA-3404	Pin Hole Cave; cut tibia: Arctic hare	12,510 ± 110	AM 18
OxA-4754	Pin Hole Cave· pre-maxillary (neo-natal): hyaena	37,800 ± 1600	AM 22
OxA-3706	Plunkett Cave, Co. Sligo, Ireland; humerus: brown bear, 2nd layer	11,920 ± 85	Woodman *et al.* (1997)
OxA-3693	Plunkett Cave; tibia: red deer, 2nd layer	11,790 ± 120	Woodman *et al.* (1997)
OxA-3708	Plunkett Cave; mandible: wolf, 2nd layer	11,150 ± 90	Woodman *et al.* (1997)
OxA-5736	Plunkett Cave; metatarsals/phalanges: Arctic hare, brown earth, section C	12,190 ± 130	Woodman *et al.* (1997)
OxA-5737	Plunkett Cave; limb bones: frog (*Rana temporaria*), assoc. with lemmings	550 ± 55	Woodman *et al.* (1997)
OxA-4367	Pontnewydd Cave, Clywd, Wales; femur: bear	25,970 ± 330	AM 22
OxA-4368	Pontnewydd Cave; radius/ulna: reindeer	28,950 ± 450	AM 22
OxA-4369	Pontnewydd Cave; radius: ?wolf	28,730 ± 420	AM 22
OxA-4371	Pontnewydd Cave; calcaneum: Arctic hare	32,870 ± 660	AM 22
OxA-4372	Pontnewydd Cave; radius: red fox	28,470 ± 410	AM 22
OxA-4373	Pontnewydd Cave; calcaneum: cervid	27,070 ± 360	AM 22
OxA-6267	Pontnewydd Cave; phalange: woolly rhino	33,200 ± 650	AM 22
OxA-1117	Quanterness, Orkney, Scotland; bone: fox	1,980 ± 80	AM 6
Q-1465	Quanterness; chamber fill, primary occupation of round house	2,570 ± 85	Renfrew *et al.* (1976)
Q-1464	Quanterness; primary occupation of round house	2,440 ± 85	Renfrew *et al.* (1976)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
Q-1463	Quanterness; subsequent to secondary phase of round house	2,130 ± 60	Renfrew *et al.* (1976)
	Quanterness; chamber fill	4,110 ± 110	Renfrew *et al.* (1976)
	Quanterness; chamber fill	4,540 ± 110	Renfrew *et al.* (1976)
HAR-228	Ram's Hill, Berkshire; charcoal	3,020 ± 90	Cunliffe (1993)
HAR-229	Ram's Hill; ash	2,960 ± 80	Cunliffe (1993)
HAR-230	Ram's Hill; charcoal	2,690 ± 70	Cunliffe (1993)
HAR-231	Ram's Hill; charcoal	3,000 ± 90	Cunliffe (1993)
HAR-232	Ram's Hill; charcoal	3,010 ± 70	Cunliffe (1993)
OxA-736	Robin Hood's Cave, Derbyshire; mandible: human	2,020 ± 80	AM 4
OxA-6581	Robin Hood's Cave; mandible frags: human (repeat of OxA-736)	1,785 ± 50	AM 24
OxA-199	Robin Hood's Cave; charcoal, C3 layer LSB	>36,000	AM 3
OxA-1462	Robin Hood's Cave; ivory frag: mammoth	12,320 ± 120	AM 9
OxA-1616	Robin Hood's Cave; cut scapula: mountain hare, AI, USB/OB, Spit 12	12,600 ± 170	AM 9
OxA-1617	Robin Hood's Cave; cut femur: mountain hare, AI, OB, Spit 16	12,420 ± 200	AM 9
OxA-1670	Robin Hood's Cave; cut humerus: mountain hare, AI, LSB, Spit 18	12,290 ± 120	AM 9
OxA-1618	Robin Hood's Cave; cut scapula: mountain hare, AI, LSB/A, Spit 21	12,480 ± 170	AM 9
OxA-1619	Robin Hood's Cave; cut humerus: mountain hare, AI, LSB/A, Spit 21	12,450 ± 150	AM 9
BM-601	Robin Hood's Cave; wood charcoal, (derived from underlying sand A), sandy scree B/A	>40,000	Campbell (1977)
BM-602	Robin Hood's Cave; bone: brown bear, intrusive, tip E/sharp scree USB	28,500 +1600/-1300	Campbell (1977)
OxA-3415	Robin Hood's Cave; cut scapula: Arctic hare	12,340 ± 120	AM 18
OxA-3416	Robin Hood's Cave; tibia (pointed end of awl): Arctic hare	12,580 ± 110	AM 18
OxA-3454	Robin Hood's Cave; tooth: woolly rhino, RH 69, AI, LSB spit 18	42,900 ± 2400	AM 18
OxA-3455	Robin Hood's Cave; tooth: woolly rhino	29,300 ± 480	AM 18
OxA-5801	Robin Hood's Cave; tooth: hyaena, AI, USB OB,spit 12	33,450 ± 700	AM 22
OxA-5802	Robin Hood's Cave; tooth: hyaena, AI, OB,spit 16	31,050 ± 500	AM 22
BM-2546	Runnymede Bridge, Surrey; bone sample	4,600 ± 90	RC17
OxA-1030	Seamer Carr, N. Yorkshire; vertebra: domestic dog, 20561	9,940 ± 100	AM 6
BM-1841	*Seamer Carr; rib: aurochs*	8,620 ± 80	*RC9*
BM-1841R	Seamer Carr [recalculated date]	8,740 ± 120	RC16
SRR-146	Seamer Carr; detritus, mud deposit	13,042 ± 140	Campbell (1977)
CAR-197	Seamer Carr; charcoal, from sands at lake edge	9,330 ± 84	Spratt (1982)
CAR-196	Seamer Carr; bones: aurochs/red deer, in marginal peats	9,150 ± 95	Spratt (1982)
OxA-8095	Sewell's Cave, N. Yorkshire; bone: aurochs, 3a	10,775 ± 75	S. Stallibrass & P. Rowley-Conwy (pers. comm.)
OxA-8096	Sewell's Cave, N. Yorkshire; bone· reindeer, 3b	10,740 ± 65	S. Stallibrass & P. Rowley-Conwy (pers comm)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-3607	Shandon Cave, Co. Waterford, Ireland; tooth: mammoth	27,150 ± 350	Woodman *et al.* (1997)
OxA-3608	Shandon Cave; humerus: red deer	26,090 ± 320	Woodman *et al.* (1997)
OxA-4243	Shandon Cave; radius: reindeer	30,840 ± 550	Woodman *et al.* (1997)
OxA-4245	Shandon Cave; calcaneum: brown bear	32,430 ± 670	Woodman *et al.* (1997)
OxA-4246	Shandon Cave; mandible: wolf	27,500 ± 420	Woodman *et al.* (1997)
OxA-4247	Shandon Cave; humerus: goose (*Anser* sp.)	30,900 ± 540	Woodman *et al.* (1997)
OxA-4248	Shandon Cave; tibia: Arctic fox	29,980 ± 560	Woodman *et al.* (1997)
OxA-4365	Shandon Cave; humerus: Arctic hare	28,240 ± 400	Woodman *et al.* (1997)
Birm-477	*Skara Brae, Orkney, Scotland; bone: Bos (low ^{13}C concentration)*	*3,950 ± 100*	*RC2*
Birm-478	Skara Brae; bone: *Bos*	3,850 ± 140	*RC2*
Birm-479	Skara Brae; bone: *Bos*	4,320 ± 100	*RC2*
Birm-433	Skara Brae; bone: *Bos*, midden material	3,830 ± 110	RC1
Birm-434	Skara Brae; bone: *Bos*, midden material	4,020 ± 110	RC1
Birm-435	Skara Brae; bone: *Bos*, midden material	3,870 ± 100	RC1
Birm-436	Skara Brae; bone: *Bos*, midden material	4,040 ± 110	RC1
Birm-437	Skara Brae; bone: *Bos*, midden material	3,780 ± 110	RC1
Birm-438	Skara Brae; bone: *Bos*, midden material	4,140 ± 120	RC1
OxA-8097	Skipsea Withow, Humberside; antler: red deer, 6a	9,520 ± 55	S. Stallibrass & P. Rowley-Conwy (pers. comm.)
NPL-141	Snail Down, Wiltshire; pyre under barrow with collared urn	3,490 ± 90	Cunliffe (1993)
OxA-4178	Snail Down (XIV); charcoal: *Fraxinus*	3,555 ± 75	AM 20
OxA-4179	Snail Down (XVII); charcoal: *Pomoideae*	3,480 ± 70	AM 20
OxA-4211	Snail Down (XXII); bone (juvenile): human	3,485 ± 110	AM 20
HAR-260	Sproughton, Suffolk; wood, ?low Zone II silt, ?below barbed point and flints	11,940 ± 180	Campbell (1977)
HAR-261	Sproughton; wood & leaves, ?Zone II sands and gravels, ?below barbed point/flints	11,640 ± 500	Campbell (1977)
HAR-262	Sproughton; wood, leaves & peat, ?Zone II sands/gravels, ?below barbed point/flints	11,370 ± 210	Campbell (1977)
HAR-259	Sproughton; wood: *Salix*, ?Zone IV/III sands/gravels, ?above barbed point/flints	9,880 ± 120	Campbell (1977)
OxA-517	Sproughton; uniserial bone point (1)	10,910 ± 150	AM 3
OxA-518	Sproughton; uniserial antler point (2)	10,700 ± 160	AM 3
BM-63	Staple Howe, N. Yorkshire; grain, phase II ditch	2,400 ± 150	Brewster (1963)
Q-14	Star Carr, N. Yorkshire; wood: *Betula*, platform Zone IV	9,557 ± 210	Campbell (1977)
C-353	Star Carr, N. Yorkshire; wood: *Betula*, platform Zone IV (solid carbon)	9,488 ± 350	Campbell (1977)
OxA-4902	Stonehenge, Wiltshire; animal bone, Stonehole 27	5,350 ± 80	AM 22
OxA-4833	Stonehenge; tibia: red deer, southern entrance	4,550 ± 60	AM 22
OxA-4835	Stonehenge; jaw: ox, southern entrance	4,455 ± 40	AM 22

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-4834	Stonehenge; jaw: ox, southern entrance	4,460 ± 45	AM 22
OxA-4842	Stonehenge; skull: ox, southern entrance	4,520 ± 100	AM 22
OxA-4904	Stonehenge; antler: cervid, ditch A-E, C41	4,365 ± 55	AM 22
OxA-4881	Stonehenge; animal bone, ditch L-Q, C42	4,300 ± 60	AM 22
OxA-4841	Stonehenge; animal bone, ditch A-E, C41	4,295 ± 60	AM 22
OxA-4882	Stonehenge; animal bone, ditch A-E, C41	4,270 ± 65	AM 22
OxA-4880	Stonehenge; animal bone, ditch A-E, C41	3,875 ± 55	AM 22
OxA-4843	Stonehenge; animal bone, ditch A-E, C41	4,315 ± 60	AM 22
OxA-4883	Stonehenge; bone chisel, ditch, C26	4,300 ± 70	AM 22
OxA-5981	Stonehenge; piglet, ditch, C20	4,220 ± 35	AM 22; AM 23
OxA-5982	Stonehenge; vertebra: cattle, ditch L-Q, C42	4,405 ± 30	AM 22; AM 23
OxA-4837	Stonehenge; antler: cervid, C3	3,995 ± 60	AM 22
OxA-4838	Stonehenge; antler: cervid, C3	3,885 ± 40	AM 22
OxA-4886	Stonehenge; femur: human	3,960 ± 60	AM 22
OxA-5044	Stonehenge; femur: human	3,785 ± 70	AM 22
OxA-5045	Stonehenge; femur: human	3,825 ± 60	AM 22
OxA-5046	Stonehenge; femur: human	3,775 ± 55	AM 22
OxA-4840	Stonehenge; antler: cervid	3,985 ± 45	AM 22
OxA-4839	Stonehenge; antler: cervid	3,860 ± 40	AM 22
OxA-4878	Stonehenge; animal bone, Stonehole 40c	3,740 ± 40	AM 22
OxA-4900	Stonehenge; antler: cervid, Stonehole 40c	3,865 ± 50	AM 22
OxA-4877	Stonehenge antler. cervid, Stonehole 63a	3,695 ± 55	AM 22
OxA-4836	Stonehenge; antler: cervid, Z Hole 29	3,540 ± 45	AM 22
OxA-4884	Stonehenge; antler: cervid, northern ditch, C6	3,935 ± 50	AM 22
OxA-4905	Stonehenge; antler: cervid, southern ditch, C96	3,865 ± 40	AM 22
OxA-535	Sun Hole Cave, Somerset; ulna: human, 5th ft. Pleistocene deposits	12,210 ± 160	AM 3
BM-524	Sun Hole Cave; humerus: brown bear	12,378 ± 160	RC6
Birm-819	Sun Hole Cave; frag bones: reindeer, 3rd ft. Pleistocene deposits	10,110 ± 160	Collcutt *et al.* (1981)
BM 1808	*Swildon's Hole, Somerset*	1,730 ± 60	*RC9*
BM-1808R	Swildon's Hole [recalculated date]	1,960 ± 120	RC16
OxA-3720	Sydenham Station, Co Down, N Ireland; mandible· red deer	2,020 ± 65	Woodman *et al* (1997)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
BM-65	Thatcham II, Berkshire; charcoal/peat, layer 2 (?contaminated)	8100 ± 180	RC3; Campbell (1977)
Q-658	Thatcham III; wood/charcoal & nuts: *Corylus*, hearth	10,030 ± 170	RC36; Campbell (1977)
Q-659	Thatcham III; wood/charcoal, hearth	10,365 ± 170	RC36; Campbell (1977)
OxA 1201	*Thatcham III; femur: beaver, F3 12 layer 4*	5,100 ± 350	*AM 8*
OxA 940	*Thatcham III; humerus: pig, G3 5 layer 4*	6,550 ± 130	*AM 8*
OxA-732	Thatcham IV; worked antler beam: cervid, 70.3018	9,760 ± 120	AM 5
OxA-894	Thatcham IV; burnt antler: elk, 70.3018	9,490 ± 110	AM 5
OxA-1022	Thatcham V; bone: rabbit (*Oryctolagus cuniculus*)	270 ± 180	AM 5
Q-650	Thatcham V; wood, Zone V, marl	9,670 ± 160	RC36; Campbell (1977)
Q-652	Thatcham V; wood: *Pinus*, Zone VIa, marl	9,490 ± 160	RC36; Campbell (1977)
OxA-5190	Thatcham V; cut calcaneum: roe deer, TH5-2, layer 5	9,430 ± 100	AM 21
Q-677	Thatcham V; wood, Zone VI, marl	9,780 ± 160	RC36; Campbell (1977)
OxA-5191	Thatcham V; cut phal I: red deer, TH5-3, layer 5	9,510 ± 90	AM 21
OxA-5192	Thatcham V; charred hazelnut shell, TH5-6	9,400 ± 80	AM 21
Q-651	Thatcham V; wood: *Betula & Pinus*, Zone IV, marl	9,840 ± 160	RC36; Campbell (1977)
BM-2355	Thickthorn Down, Dorset; antler: cervid, beneath mound	5,160 ± 45	Cunliffe (1993)
BM-1807	*Thor's Fissure Cave, Staffordshire*	20,100 ± 1900	*RC10*
BM-1807R	Thor's Fissure Cave [recalculated date]	20,400 ± 1900	RC16
OxA-1501	Three Holes Cave, Devon; burnt bone frag, 3H 57 II 8b	11,520 ± 150	AM 9
OxA-1500	Three Holes Cave; cut bone frag, 3H 57 II 8b	12,350 ± 160	AM 9
OxA-3208	Three Holes Cave; calcaneum: Arctic hare	12,260 ± 140	AM 22
OxA-3209	Three Holes Cave; humerus: brown bear	12,180 ± 130	AM 22
OxA-3891	Three Holes Cave; metatarsal: red deer	11,980 ± 100	AM 22
OxA-4478	Three Holes Cave; humerus: red deer	10,020 ± 80	AM 22
OxA-3889	Three Holes Cave; plastron fragment: *Emys orbicularis*	4,650 ± 70	AM 22
OxA-4491	Three Holes Cave; radius: red deer	6,330 ± 75	AM 22
OxA-4492	Three Holes Cave; cubo-navicular: red deer	6,120 ± 75	AM 22
OxA-4493	Three Holes Cave; tooth: aurochs	5,060 ± 70	AM 22
OxA-4495	Three Holes Cave; tooth: aurochs	5,010 ± 70	AM 22
OxA-3210	Three Holes Cave; mandible: human	1,540 ± 80	AM 22
BM 1676	*Tolpit's Lane, Hertfordshire; 5th lumbar vertebra. aurochs from c.1m in peaty deposits*	5,230 ± 60	*RC9*
BM-1676R	Tolpit's Lane [recalculated date]	5,540 ± 110	RC16
OxA-3894	Torbryan 6, Devon; cut dentary: reindeer	11,130 ± 100	AM 22
OxA-3895	Torbryan 6; axis vertebra: Arctic hare	12,130 ± 110	AM 22

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-3185	Tornewton Cave, Devon; bone: bovid, Reindeer Stratum	27,400 ± 480	AM 22
OxA-3186	Tornewton Cave; bone: mammal, Reindeer Stratum	34,750 ± 900	AM 22
OxA-3892	Tornewton Cave; antler: reindeer	32,190 ± 640	AM 22
OxA-3893	Tornewton Cave; tooth: woolly rhino	32,180 ± 580	AM 22
OxA-4587	Tornewton Cave; dentary: glutton	22,160 ± 460	AM 22
OxA-5864	Tornewton Cave; tooth: human, Reindeer Stratum	4,680 ± 60	AM 24
OxA-2453	Victoria Cave, N. Yorkshire; grooved double bevelled point	10,220 ± 110	AM 14
OxA-2454	Victoria Cave; mandible: reindeer, close cave mouth, lower part lower breccia	10,970 ± 120	AM 14
OxA-2455	Victoria Cave; broken double bevelled artefact	11,750 ± 120	AM 14
OxA-2457	Victoria Cave; radius: reindeer,	11,590 ± 130	AM 14
OxA-2607	Victoria Cave; biserially barbed harpoon, close cave mouth, lower part lower breccia	10,810 ± 100	AM 14
BM-767	Wawcott III, Berkshire; charcoal	6,120 ± 134	RC7
BM-449	Wawcott site I; wood	5,260 ± 130	RC6
BM-826	Wawcott XXIII; charcoal	6,079 ± 113	RC7
BM-2719	*Wawcott XXX; tibia: Bos sp.*	6,130 ± 100	*RC18*
BM-2718	*Wawcott XXX; metacarpal & femur: elk & aurochs*	10,960 ± 100	*RC18*
BM-2597	West Kennet, Wiltshire; antler: red deer	3,810 ± 50	RC17
BM-2602	West Kennet; antler: red deer	3,620 ± 50	RC17
OxA-449	West Kennet Long Barrow, Wiltshire; bone: human	4,825 ± 90	AM 2
OxA-450	West Kennet Long Barrow; bone: human	4,700 ± 80	AM 2
OxA-451	West Kennet Long Barrow; bone: human	4,780 ± 90	AM 2
OxA-563	West Kennet Long Barrow; bone: human	4,780 ± 90	AM 4
OxA-1047	West Overton, Wiltshire; phal II: aurochs, cutting C, N.Farm formation tufa gravel 8d	8,390 ± 80	AM 6
OxA-1044	West Overton; tusk: wild boar, WO 241	8,260 ± 80	AM 6
OxA-1045	West Overton; skull: cattle (*Bos taurus*), WO 167	2,980 ± 100	AM 6
OxA-1048	West Overton; charcoal: *Prunus*, WO 244	3,320 ± 60	AM 6
OxA-986	West Overton; wood charcoal, WO 245	3,860 ± 70	AM 6
Q-672	Westward Ho!, Devon· peat, over midden	6,585 ± 130	Grigson (1978)
Q-1127	Wettonmill Rock Shelter, Staffordshire; bone frags.	8,847 ± 210	RC37
NPL-74	Wilsford Shaft, Wiltshire; wood, from bottom of shaft	3,330 ± 90	Cunliffe (1993)
OxA(WS1)	Wilsford Shaft; lower fill (5 grouped dates)	3,151 ± 29	Cunliffe (1993)
OxA(WS2)	Wilsford Shaft; upper fill (4 grouped dates)	2,413 ± 32	Cunliffe (1993)

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Lab No.	Site Name and Dated Material	^{14}C Date (BP)	Date Reference
OxA-2394	Windmill Hill, Wiltshire; vertebra: *Bos*	4,665 ± 70	AM 14
OxA-2395	Windmill Hill; pig	4,730 ± 80	AM 14
OxA-2396	Windmill Hill, scapula pig	4,690 ± 70	AM 14
OxA-2397	Windmill Hill; scapula: *Bos*	4,730 ± 80	AM 14
OxA-2398	Windmill Hill; calcaneum: *Bos*	4,715 ± 80	AM 14
OxA-2399	Windmill Hill; skull (child): human	4,750 ± 70	AM 14
OxA-2401	Windmill Hill; astragalus: *Bos*	4,770 ± 70	AM 14
OxA-2402	Windmill Hill; humerus: *Bos*	4,665 ± 80	AM 14
OxA-2403	Windmill Hill; rib: human	4,745 ± 70	AM 14
OxA-2404	Windmill Hill; scapula: pig	4,650 ± 70	AM 14
OxA-2405	Windmill Hill; humerus: *Bos*	4,550 ± 80	AM 14
OxA-2406	Windmill Hill; vertebra: *Bos*	4,870 ± 70	AM 14
BM-73	Windmill Hill	4,910 ± 150	AM 14
BM-74	Windmill Hill; bulked sample	4,530 ± 150	AM 14
BM-2670	Windmill Hill	4,670 ± 90	AM 14
BM-2671	Windmill Hill	4,550 ± 50	AM 14
BM-2672	Windmill Hill	4,370 ± 50	AM 14
BM-2669	Windmill Hill; bones	4,740 ± 50	Cunliffe (1993)
BM-2673	Windmill Hill, bones	4,310 ± 60	Cunliffe (1993)
BM-75	Windmill Hill	3,500 ± 150	Cunliffe (1993)
OxA-4579	Windy Knoll, Derbyshire; radius: bison	37,300 ± 1100	AM 22
BM-677	Woodhenge, Wiltshire; antler: cervid, primary ditch silt	3,817 ± 74	Cunliffe (1993)
BM-678	Woodhenge, Wiltshire; bone, primary ditch silt	3,755 ± 54	Cunliffe (1993)
BM-2283	*Wor Barrow, Dorset; antler: cervid, from primary fill of ditch*	4,350 ± 70	*RC13*
BM-2283R	Wor Barrow [recalculated date]	4,660 ± 130	RC16
BM-2284	*Wor Barrow; antler: cervid, from ditch bottom*	4,440 ± 70	*RC13*
BM-2284R	Wor Barrow [recalculated date]	4,740 ± 130	RC16

Radiocarbon Dates for Horse Material from Continental European Sites

Lab No.	Site with Dated Horse Material	Radiocarbon Date	
		^{14}C Date (BP)	Error ±
Ly-560	Solutré, France	> or = 30,400	
Ly-312	Solutré, France	28,650	1100
OxA-4115	Kostenki XIV (Markina Gora site), Russia	28,580	420
OxA-4117	Kostenki XIV (Markina Gora site), Russia	27,710	410
OxA-4116	Kostenki XIV (Markina Gora site), Russia	27,460	390
OxA-4124	Brinzeni Cave, Moldavia	26,200	360
Ly-317	Solutré, France	24,050	600
Ly-561	Solutré, France	23,200	700
Ly-313	Solutré, France	22,650	500
OxA-4119	Brinzeni Cave, Moldavia	22,530	250
OxA-4121	Brinzeni Cave, Moldavia	22,330	230
Ly-562	Solutré, France	21,600	700
OxA-4426	Ciuntu Cave, Moldavia	21,000	220
TA-154	Kostenki XII, Russia	20,900	390
OxA-4898	Brinzeni Cave, Moldavia	20,140	260
OxA-4899	Brinzeni Cave, Moldavia	19,780	260
Ly-1533	Solutré, France	19,590	280
Ly-1534	Solutré, France	17,310	470
Ly-316	Solutré, France	17,150	300
Lv-467	*Oetrange 2, Luxembourg*	*16,770*	*390*
Ly-314	*Solutré, France*	*16,740*	*300*
OxA-4123	Brinzeni Cave, Moldavia	16,600	160
R-1062	*Taurisano, Italy*	*16,050*	*160*
R-1064	*Taurisano, Italy*	*16,000*	*150*
R-1063	*Taurisano, Italy*	*15,600*	*120*
R-1061	*Taurisano, Italy*	*15,500*	*150*
OxA-6730	**Solutré, France**	**15,080**	**130**
OxA-4120	Brinzeni Cave, Moldavia	14,700	130
R-944	*Palidoro T1 1, Italy*	*14,580*	*130*
OxA-6731	**Solutré, France**	**14,570**	**130**
Ly-1532	Solutré, France	14,360	280
GIN-79	Kostenki XIV (Markina Gora site), Russia	14,300	460
Ly-2453	Maszycka Cave, Poland	14,250	240
Ly-1689	Les Blaches, France	14,110	620
Ly-1531	Solutré, France	13,710	230
Ly-1530	Solutré, France	13,680	240
OxA-4852	Kniegrotte, Germany	13,520	130
OxA-4200	Trou des Blaireaux, Belgium	13,330	160
OxA-6667	**Bruniquel (Courbet), France**	**13,230**	**90**
OxA-1128	Andernach-Martinsberg II, Germany	13,200	140
OxA-4846	Kniegrotte, Germany	13,190	130
OxA-4848	Kniegrotte, Germany	13,150	130
OxA-1129	Andernach-Martinsberg II, Germany	13,090	130
Z-2423	*Sandalja II, Croatia*	*13,050*	*220*
H-7142-7348	Petersfels, Germany	12,980	90
OxA-1130	Andernach-Martinsberg III, Germany	12,950	140
Ly-2553	Pekarna Cave, Czech. Republic	12,940	250
OxA-1125	Andernach-Martinsberg I, Germany	12,930	180

Radiocarbon Dates for Horse Material from Continental European Sites

Lab No.	Site with Dated Horse Material	Radiocarbon Date	
		^{14}C Date (BP)	Error ±
OxA-1126	Andernach-Martinsberg I, Germany	12,890	140
OxA-3633	Trou de Chaleux, Belgium	12,880	100
OxA-4041	Grotte de Sy Verlaine, Belgium	12,870	110
OxA-3635	Grotte du Coléoptère, Belgium	12,870	95
OxA-1127	Andernach-Martinsberg II, Germany	12,820	130
OxA-5261 (Lyon-131)	La Fru (abri sous de La Fru), France	12,810	110
BM-2286R	*Les Eyzies (Grotte des Eyzies), France*	*12,810*	*990*
OxA-4197	Trou du Frontal (Furfooz), Belgium	12,800	130
OxA-3632	Trou de Chaleux, Belgium	12,790	100
OxA-5262 (Lyon-132)	La Fru (abri sous de La Fru), France	12,770	110
OxA-5263 (Lyon-133)	La Fru (abri sous de La Fru), France	12,740	110
OxA-5753	*Sesselfelsgrotte, Germany*	*12,740*	*90*
H-7141-6985	Petersfels, Germany	12,680	110
OxA-5754	*Sesselfelsgrotte, Germany*	*12,680*	*100*
Ly-1172	*Gönnersdorf No.2, Germany*	*12,660*	*370*
OxA-3139	*Le Grand Canton, France*	*12,650*	*130*
OxA-4195	Trou des Nutons (Furfooz), Belgium	12,630	140
OxA-4408 (Lyon-29)	La Fru (abri sous de La Fru), France	12,600	120
BM-2286	*Les Eyzies (Grotte des Eyzies), France*	*12,590*	*980*
Ly-393	Solutré, France	12,580	250
H-7137-7067	Petersfels, Germany	12,470	100
Ly-1108	Sanuv Kout, former Czechoslovakia	12,420	470
OxA-730	*Moque Panier-LeTilloy, France*	*12,300*	*160*
Ly-6988	Le Tureau des Gardes, France	12,290	90
OxA-5995 (Lyon-202)	Etiolles/Les Coudrays, France	12,250	100
OxA-731	*Moque Panier, France*	*12,240*	*160*
H-7139-7300	Petersfels, Germany	12,180	100
B-4261	Birseck-Ermitage, Switzerland	12,040	80
B-4184	Rheinfelden-Eremitage, Switzerland	11,950	50
BM-2285R	*Les Eyzies (Grotte des Eyzies), France*	*11,780*	*390*
BM 2285	*Les Eyzies (Grotte des Eyzies), France*	*11,600*	*380*
B-4183/C137	Rheinfelden-Eremitage, Switzerland	11,600	120
H-4741-4145	Petersfels, Germany	11,300	85
OxA-1135	Neiderbieber III, Germany	11,130	130
Ly-1173	*Gönnersdorf No.3, Germany*	*11,100*	*650*
OxA-3671	*Le Grand Canton, France*	*11,030*	*105*
Ly-315	*Solutré, France*	*10,900*	*400*
OxA-1392	Kaster, Germany	10,380	140
OxA-724	Belloy-sur-Somme, France	10,260	160
Z-2421	*Sandalja II, Croatia*	*10,140*	*160*
OxA-722	Belloy-sur-Somme, France	10,110	130
OxA-723	Belloy-sur-Somme, France	9,890	150
OxA-462	Belloy-sur-Somme, France	9,720	130
OxA-461	*Belloy-sur-Somme, France*	*8,010*	*110*
OxA-1131	Cueva de la Carigüela, Spain	7,010	90
Gif-2125	*Grotte de Kitsos, Greece*	*6,800*	*170*
ETH-9345	Bruchsal/Aue, Germany	6,670	80
OxA-1134	*Niederbieber II, Germany*	*6,250*	*130*

Radiocarbon Dates for Horse Material from Continental European Sites

Lab No.	Site with Dated Horse Material	Radiocarbon Date	
		^{14}C Date (BP)	Error ±
Hd-14272	Schwanfeld, Germany	5,735	50
ETH-9341	Bruchsal/Aue, Germany	5,305	70
ETH-9342	Bruchsal/Aue, Germany	5,050	75
ETH-9344	Bruchsal/Aue, Germany	5,040	65
ETH-9343	Bruchsal/Aue, Germany	4,905	65
ETH-9338	Bruchsal/Aue, Germany	4,855	70
ETH-9346	Bruchsal/Aue, Germany	4,810	65
k-2652	Lindskov, Denmark	4,520	65
Ly-392	*Solutré 15, France*	*3,350*	*350*
Ly-1098	Auvernier, Switzerland	3,190	200
BM-2193R	Moncín, Spain	3,080	120
BM-2194R	Moncín, Spain	3,060	120
BM-2193	*Moncín, Spain*	*2,860*	*60*
BM-2194	*Moncín, Spain*	*2,840*	*70*
VRI-113	Bregenz 1, Austria	2,000	80
Ly-1578	*Igues de Bramarie, France*	*1,900*	*600*
Gif-1572	Nissan-les-Ensérune, France	1,750	100
ETH-9339	Bruchsal/Aue, Germany	1,255	55
Lu-917	Hagestad, Scania	1,230	50
Lu-1053	Stora Råby 2, Scania	1,220	50
Lu-1150	Eketorp Fen 1, Sweden	1,100	55
OxA-1393	Lonsberg, Germany	1,030	90
ETH-9340	Bruchsal/Aue, Germany	1,020	55
Lu-1077	Löddeköpinge, Scania	1,020	50
Lu-1080	Löddeköpinge, Scania	1,010	50
Lu-525	Hagestad, Scania	900	50
Ly-363	*Albigny, France*	*460*	*100*
Ly-547	*Trou Bernier, France*	*370*	*100*
Lu-1464	Källby, Scania	270	45

Radiocarbon Dates for Horse Material from Continental European Sites: with specimen and stratigraphy information

Lab No.	Site and Dated Horse Material	^{14}C Date (BP)	Date Reference
Ly-363	*Albigny, France; bones, mixed species (ass+ ox), ditches castle*	*460 ± 100*	*RC29*
OxA-1128	Andernach-Martinsberg II,Germany; rib+ bone frags, A-M11, pit 35 N50	13,200 ± 140	AM6
OxA-1129	Andernach-Martinsberg II; rib+ bone frags (zygopodium), A-M12, pit 35	13,090 ± 130	AM6
OxA-1130	Andernach-Martinsberg III; bone frags, Magdalenian V, pit 28 N30	12,950 ± 140	AM6
OxA-1126	Andernach-Martinsberg I; rib frag, A-M9, pit 20, Pl 50-41	12,890 ± 140	AM6
OxA-1125	Andernach-Martinsberg I; cancellous bone+ rib frags, pit 20 N70, N80	12,930 ± 180	AM6
OxA-1127	Andernach-Martinsberg II; bone frags, Magdalenian V, Grube 12 N50	12,820 ± 130	AM6
Ly-1098	Auvernier, Canton de Neuchatel, Switzerland; complete skeleton	3,190 ± 200	RC31
OxA-722	Belloy-sur-Somme, France; tooth, B117 S17, no.17	10,110 ± 130	AM4
OxA-461	*Belloy-sur-Somme; tooth, B117 S17, no.17 (low amino acid yield)*	*8,010 ± 110*	*AM4*
OxA-462	Belloy-sur-Somme; tooth, B117 S18, no.44	9,720 ± 130	AM4
OxA-723	Belloy-sur-Somme; tooth, B131 H17, no.215	9,890 ± 150	AM4
OxA-724	Belloy-sur-Somme; tooth, B131 I19, no.94	10,260 ± 160	AM4
B-4261	Birseck-Ermitage, Switzerland; bone (*Equus* sp.), couche inferieure Magd.	12,040 ± 80	M. Street (pers. comm.)
VRI-113	Bregenz 1, Vorarlberg, Austria; horse dung, Roman camp stables	2,000 ± 80	RC41
OxA-4899	Brinzeni Cave, Edinet region, Moldavia; bone, cultural layer 3	19,780 ± 260	AM21
OxA-4124	Brinzeni Cave; long bone, cultural layer 3	26,200 ± 360	AM21
OxA-4120	Brinzeni Cave; long bone, cultural layer 3, sq. E15	14,700 ± 130	AM21
OxA-4121	Brinzeni Cave, horse long bone, cult.layer 3, sq. E15	22,330 ± 230	AM21
OxA-4898	Brinzeni Cave; mandible, cultural layer 3	20,140 ± 260	AM21
OxA-4119	Brinzeni Cave; tooth, cultural layer 3, sq. E15	22,530 ± 250	AM21
OxA-4123	Brinzeni Cave; tooth, cultural layer 3, sq. B15	16,600 ± 160	AM21
ETH-9338	Bruchsal/Aue, Germany; tibia, Area III Section 6 3-4, #729	4,855 ± 70	Steppan (1994)
ETH-9341	Bruchsal/Aue; metacarpus, Area I Section 2 9-10, #215	5,305 ± 70	Steppan (1994)
ETH-9345	Bruchsal/Aue; metacarpus, Area III Section 6 3-4, #729	6,670 ± 80	Steppan (1994)
ETH-9342	Bruchsal/Aue; metacarpus, Area IV Section 18 ps8, #2491	5,050 ± 75	Steppan (1994)
ETH-9343	Bruchsal/Aue; metatarsus, Area III Section 6 2-3, #676	4,905 ± 65	Steppan (1994)
ETH-9344	Bruchsal/Aue; pelvis, Area II Section 5 2-3, #1747	5,040 ± 65	Steppan (1994)

Radiocarbon Dates for Horse Material from Continental European Sites: with specimen and stratigraphy information

Lab No.	Site and Dated Horse Material	^{14}C Date (BP)	Date Reference
ETH-9340	Bruchsal/Aue; phal I, Area I Section 1 2-3, #615	1,020 ± 55	Steppan (1994)
ETH-9339	Bruchsal/Aue; phal II, Area III Section 14 3/4-4, #1368	1,255 ± 55	Steppan (1994)
ETH-9346	Bruchsal/Aue; radius/ulna, Area III Section 15 5-6, #2196	4,810 ± 65	Steppan (1994)
OxA-6667	**Bruniquel (Courbet), Tarn-et-Garonne, France; lower P3, no.39325**	**13,230 ± 90**	**L.M. Kaagan**
OxA-4426	Ciuntu Cave, Briciani, Moldavia; tooth, layer 3, sq. K4	21,000 ± 220	AM21
OxA-1131	Cueva de la Carigüela, Granada, Spain; metacarpus, 402/15	7,010 ± 90	AM6
Lu-1150	Eketorp Fen 1, S. Öland, Sweden; lower jaw frag., fen deposits	1,100 ± 55	RC25
OxA-5995 (Lyon-202)	Etiolles/Les Coudrays, Essone, France; bones	12,250 ± 100	AM24
Ly-1172	*Gönnersdorf No.2, Germany; bone frags. (mainly horse ribs), soil*	*12,660 ± 370*	*RC31*
Ly-1173	*Gönnersdorf No.3; bone (mainly horse ribs), pits base hab soil*	*11,100 ± 650*	*RC31*
Gif-2125	*Grotte de Kitsos,Laurion,Greece; bones, mixed species (incl. horse)*	*6,800 ± 170*	*RC19*
OxA-4041	Grotte de Sy Verlaine,Prov.of Luxembourg, Belgium; cut pisiform	12,870 ± 110	AM18
OxA-3635	Grotte du Coléoptère à Bomal-sur-Ourthe, Belgium; cut phal. I, couche7/8	12,870 ± 95	AM16
Lu-525	Hagestad, Löderup, Scania; bone, 48[3], Feature 2:71	900 ± 50	RC22
Lu-917	Hagestad; tibia, in bog soil assoc. w/ pottery 6[2], Sample3: HT73	1,230 ± 50	RC23
Ly-1578	*Igues de Bramarie,Caniac du Causse, France; bones of Equidae*	*1,900 ± 600*	*RC32*
Lu-1464	Källby, Lund, Scania; tibia, associated with human bones	270 ± 45	RC26
OxA-1392	Kaster, Rhineland, Germany; bone, KS-1	10,380 ± 140	AM9
OxA-4848	Kniegrotte, Thuringen, Germany; metatarsal, Feustel layer VIII "triangle"	13,150 ± 130	M. Street (pers. comm.)
OxA-4852	Kniegrotte; cut lumbar vertebra, Feustel layer VIII "circle"	13,520 ± 130	M. Street (pers. comm.)
OxA-4846	Kniegrotte; cut femur, Feustel layer VIII "square"	13,190 ± 130	M. Street (pers. comm.)
TA-154	Kostenki XII, Russia; bones, Palaeolithic settlement	20,900 ± 390	RC40
OxA-4115	Kostenki XIV (Markina Gora); bone, layer II, sq P-43,64, 1982 trench III	28,580 ± 420	AM21
OxA-4116	Kostenki XIV (Markina Gora); bone, layer IV, 1954 trench III	27,460 ± 390	AM21
OxA-4117	Kostenki XIV (Markina Gora); bone, layer IV, sq X-41, 1954 trench III	27,710 ± 410	AM21
GIN-79	Kostenki XIV (Markina Gora); bone frags., campsite, strat. III	14,300 ± 460	RC40
OxA-4408 (Lyon-29)	La Fru (abri sous de La Fru), Savoie, France; radius, F24-924	12,600 ± 120	AM24
OxA-5261 (Lyon-131)	La Fru; tooth, base c.4B, E 22-368	12,810 ± 110	AM24

Radiocarbon Dates for Horse Material from Continental European Sites: with specimen and stratigraphy information

Lab No.	Site and Dated Horse Material	^{14}C Date (BP)	Date Reference
OxA-5263 (Lyon-133)	La Fru; bone, F22-450	12,740 ± 110	AM24
OxA-5262 (Lyon-132)	La Fru; bone, E22-612	12,770 ± 110	AM24
OxA-3139	*Le Grand Canton, Marolles-sur-Seine, France; LGC82 D13 33*	*12,650 ± 130*	*AM16*
OxA-3671	*Le Grand Canton; (expected date -using collagenase method)*	*11,030 ± 105*	*AM16*
Ly-6988	Le Tureau des Gardes, Marolles-sur-Seine, France; bone	12,290 ± 90	Bridault (1996)
Ly-1689	Les Blaches, Salaise-sur-Sanne, France; femur/humerus, c. 15-18m depth	14,110 ± 620	RC32
BM-2285	*Les Eyzies (Grotte des Eyzies), France; mixed species (horse+ bison)*	*11,600 ± 380*	*RC13*
BM-2285R	*Les Eyzies [recalculated date]*	*11,780 ± 390*	*RC16*
BM-2286	*Les Eyzies; bone, mixed species (probably horse+ bison)*	*12,590 ± 980*	*RC13*
BM 2286R	*Les Eyzies [recalculated date]*	*12,810 ± 990*	*RC16*
k-2652	Lindskov, Denmark; bone, 3 pits, 1899 excavation	4,520 ± 65	Clutton-Brock (1992a); Davidsen, 1978
Lu-1077	Löddeköpinge, Banvallen, Scania; mandible, Structure 15, filling layer	1,020 ± 50	RC24
Lu-1080	Löddeköpinge, Skolan 3; teeth, Structure 7, filling layer	1,010 ± 50	RC24
OxA-1393	Lonsberg, Rhineland, Germany; AC/42-79 2-32	1,030 ± 90	AM9
Ly-2453	Maszycka Cave, Poland; bone, Magdalenian	14,250 ± 240	M. Street (pers. comm.)
BM-2193	*Moncín, Borja, Zaragoza, Spain; mandibles, Quad.1, Level 3A(1980)*	*2,860 ± 60*	*RC12*
BM-2193R	Moncín [recalculated date]	3,080 ± 120	RC16
BM-2194	*Moncín; mandibles Quad1B/1D, Level4 yellowish soil (1982)*	*2,840 ± 70*	*RC12*
BM-2194R	Moncín [recalculated date]	3,060 ± 120	RC16
OxA-730	*Moque Panier-LeTilloy, France; bone (?horse), C-151.88*	*12,300 ± 160*	*AM4*
OxA-731	*Moque Panier; bone (?horse) C-151.122 (most of site's fauna is horse)*	*12,240 ± 160*	*AM4*
OxA-1135	Neiderbieber III, Germany; astragalus, 70/37-1	11,130 ± 130	Street (1993)
OxA 1134	*Niederbieber II; tooth, 72/79-18 (low collagen)*	*6,250 ± 130*	*Street (1993)*
Gif-1572	Nissan-les-Ensérune, Hérault, France; mandible in Necropolis	1,750 ± 100	RC19
Lv-467	*Oetrange 2, Luxembourg; bones (mainly horse), from filled joint*	*16,770 ± 390*	*RC27*
R-944	*Palidoro T1 1, Latium, Italy; bones, mixed species (?horse+ spp.)*	*14,580 ± 130*	*RC38*
Ly-2553	Pekarna Cave, Mokra, Moravia, Czech Republic; bones	12,940 ± 250	RC33
H-4741-4145	Petersfels, Germany; vertebral column, P3 AH2/3 7 F22	11,300 ± 85	Albrecht *et al.* (1983)

Radiocarbon Dates for Horse Material from Continental European Sites: with specimen and stratigraphy information

Lab No.	Site and Dated Horse Material	^{14}C Date (BP)	Date Reference
H-7139-7300	Petersfels; fore extremity, P1 AH3 23 R87	12,180 ± 100	Albrecht *et al.* (1983)
H-7141-6985	Petersfels; jaw/teeth, P1 AH3 21 R,T87	12,680 ± 110	Albrecht *et al.* (1983)
H-7142-7348	Petersfels; mixed specimens of horse, P1 AH4 28 S-T87	12,980 ± 90	Albrecht *et al.* (1983)
H-7137-7067	Petersfels; teeth, P1 AH3 22 V87-89,T88	12,470 ± 100	Albrecht *et al.* (1983)
B-4183/C137	Rheinfelden-Eremitage, Switzerland; bone, Magdalenian	11,600 ± 120	M. Street (pers. comm.)
B-4184	Rheinfelden-Eremitage; bone, Magdalenian	11,950 ± 50	M. Street (pers. comm.)
Z-2421	*Sandalja II, Croatia; bones, mixed species, Sandalja 1, layer B*	*10,140 ± 160*	*RC42*
Z-2423	*Sandalja II; bones, mixed species, Sandalja 2, between layers B/C*	*13,050 ± 220*	*RC42*
Ly-1108	Sanuv Kout, 'Czechoslovakia'; bones, 105-160cm depth camping site	12,420 ± 470	RC31
Hd-14272	Schwanfeld, Germany; phal III, Early Neolithic	5,735 ± 50	H.-P.Uerpmann (pers. comm.)
OxA 5753	*Sesselfelsgrotte, Germany; bone, mixed species (horse+ reindeer)*	*12,740 ± 90*	*AM23*
OxA-5754	*Sesselfelsgrotte; bone, mixed species (horse+ reindeer)*	*12,680 ± 100*	*AM23*
OxA-6730	**Solutré, Saone-et-Loire, France; cut upper P3/P4, Sol P16 34/544**	**15,080 ± 130**	**L.M. Kaagan**
OxA-6731	**Solutré; cut calcaneum, Sol I11 89/261**	**14,570 ± 130**	**L.M. Kaagan**
Ly-392	*Solutré 15; burned bones (unexplained high pollution)*	*3,350 ± 350*	*RC29*
Ly-562	Solutré; uncharred horse bones, no.7 bis, Sondage b,Terre sève	21,600 ± 700	RC30
Ly-393	Solutré; level P16, square 88-89	12,580 ± 250	RC29
Ly-317	Solutré; unburned bone, no. 11, sondage C, ?Magma layers	24,050 ± 600	RC28
Ly-560	Solutre; uncharred bones, no. 4 bis, sondage b, level 6,	>/=30,400	RC30
Ly-312	Solutré; unburned bones, no. 4, layer 6, Magma level	28,650 ± 1100	RC28
Ly-313	Solutré; unburned bone, no. 5, layer 6, Magma level	22,650 ± 500	RC28
Ly-314	*Solutré; burned bone res., no. 8 b1), assoc. Mid-Solutrean industry*	*16,740 ± 300*	*RC28*
Ly-315	*Solutré; burned bone hum. frn., no. 8 b2), assoc. Mid-Solutrean industry*	*10,900 ± 400*	*RC28*
Ly-316	Solutré; unburned bone, no. 9 b), assoc. Mid-Solutrean industry	17,150 ± 300	RC28
Ly-561	Solutré; uncharred bones, no.5 bis, Sondage b, Level 6	23,200 ± 700	RC30
Ly-1530	Solutré; bones, sqs. I/10-37, assoc. with Magd. industry	13,680 ± 240	RC32
Ly-1531	Solutré; bones, sqs. I/10-37, assoc. with Magd. industry	13,710 ± 230	RC32
Ly-1532	Solutré; bones, sqs. I 10-37-47-57, assoc. with Mid-Magdal. industry	14,360 ± 280	RC32

Radiocarbon Dates for Horse Material from Continental European Sites: with specimen and stratigraphy information

Lab No.	Site and Dated Horse Material	^{14}C Date (BP)	Date Reference
Ly-1534	Solutré; bones, sqs. I/10-37-47-57, assoc. with Mid-Solutrean industry	17,310 ± 470	RC32
Ly-1533	Solutré; bones, sqs. I/11-97 & I/10-7, assoc. with Mid-Solutrean industry	19,590 ± 280	RC32
Lu-1053	Stora Råby 2, Lund, Scania; horse mandible, object 40 settlement#2	1,220 ± 50	RC24
R-1061	*Taurisano, Apulia, Italy; bones, mixed species, T1 4-5*	*15,500 ± 150*	*RC39*
R-1062	*Taurisano; bones, mixed species, T1 6-9 Epigravettian*	*16,050 ± 160*	*RC39*
R-1063	*Taurisano; bones, mixed species, T1 10-12*	*15,600 ± 120*	*RC39*
R-1064	*Taurisano; bones, mixed species, T1 18-22*	*16,000 ± 150*	*RC39*
Ly-547	*Trou Bernier, Ain, France; bones, mixed species (horse+ ox)*	*370 ± 100*	*RC30*
OxA-3632	Trou de Chaleux, Prov.of Namur, Belgium; cut 3rd cuneiform	12,790 ± 100	AM16
OxA-3633	Trou de Chaleux; cut 3rd cuneiform	12,880 ± 100	AM16
OxA-4200	Trou des Blaireaux, Vaucelles, Belgium; ?cut proximal ulna, D75	13,330 ± 160	AM18
OxA-4195	Trou des Nutons (Furfooz), Prov.of Namur, Belgium; cut phal II	12,630 ± 140	AM18
OxA-4197	Trou du Frontal (Furfooz), Prov.of Namur, Belgium; cut metacarpal	12,800 ± 130	AM18

Radiocarbon Dates for Non-horse Material from Selected Continental European Sites

Lab No.	Site Name	Dated Material	^{14}C Date (BP)	Date Reference
H-85 91	Andernach-Martinsberg, Germany	antler; cervid (*Cervus/Rangifer*)	11,300 ± 220	Street *et al.* (1994)
OxA-1924	Andernach-Martinsberg	bone; red deer	11,890 ± 120	Street & Baales (1997)
OxA-984	Andernach-Martinsberg	bone; red deer	11,950 ± 250	AM5; AM6
OxA-985	Andernach-Martinsberg	bone; ?chamois	12,300 ± 200	AM5; AM6
OxA-998	Andernach-Martinsberg	bone; *Bos/Bison*	11,370 ± 160	AM5; AM6
OxA-999	Andernach-Martinsberg	bone; red deer [repeat of OxA-984]	12,500 ± 500	AM5; AM6
OxA-997	Andernach-Martinsberg	bone; red deer	11,800 ± 160	AM5; AM6
KN-3996	Bedburg-Königshoven, Germany	wood	10,070 ± 95	Street *et al.* (1994)
KN-4137	Bedburg-Königshoven	bone; aurochs	10,290 ± 100	Street *et al.* (1994)
KN-4139	Bedburg-Königshoven	bone; aurochs	10,140 ± 100	Street *et al.* (1994)
KN-3883A	Bedburg-Königshoven	peat	9,660 ± 120	Street *et al.* (1994)
KN-3960	Bedburg-Königshoven	wood, *Quercus*	4,230 ± 55	Street *et al.* (1994)
KN-3998	Bedburg-Königshoven	wood	9,600 ± 100	Street *et al.* (1994)
KN-3999	Bedburg-Königshoven	wood	9,780 ± 100	Street *et al.* (1994)
KN-4000	*Bedburg-Königshoven*	*peat*	10,060 ± 90	*Street et al. (1994)*
KN-4003	Bedburg-Königshoven	wood	9,310 ± 80	Street *et al.* (1994)
KN-4004	Bedburg-Königshoven	peat	9,000 ± 100	Street *et al.* (1994)
KN-4005	Bedburg-Königshoven	wood; *Betula*	9,060 ± 85	Street *et al.* (1994)
KN-4006	Bedburg-Königshoven	peat	8,010 ± 75	Street *et al.* (1994)
KN-4135	Bedburg-Königshoven	bone; aurochs	9,740 ± 100	Street *et al.* (1994)
KN-4136	Bedburg-Königshoven	bone; aurochs	10,020 ± 100	Street *et al.* (1994)
KN-4138	*Bedburg-Königshoven*	*bone; aurochs*	*10,670 ± 100*	*Street et al. (1994)*
KN-3883B	Bedburg-Königshoven	wood	9,540 ± 120	Street *et al.* (1994)
KN-3995	Bedburg-Königshoven	wood	10,270 ± 90	Street *et al.* (1994)

Radiocarbon Dates for Non-horse Material from Selected Continental European Sites

Lab No.	Site Name	Dated Material	^{14}C Date (BP)	Date Reference
KN-4001	Bedburg-Königshoven	peat	9,690 ± 85	Street *et al.* (1994)
KN-4002	Bedburg-Königshoven	peat	9,360 ± 90	Street *et al.* (1994)
KN-3997	Bedburg-Königshoven	wood	10,010 ± 85	Street *et al.* (1994)
BM-302	Bruniquel (Courbet), France	harpoon fragment	11,750 ± 300	RC5
BM-303	Bruniquel (Courbet)	antler waste	11,110 ± 160	RC5
KN-1979	*Gönnersdorf, Germany*	*Mollusca*	*10,540 ± 210*	*Street et al. (1994)*
KN-1980	Gönnersdorf	Mollusca	12,910 ± 105	Street *et al.* (1994)
OxA-2069	*Gönnersdorf II*	*mammoth ivory*	*11,830 ± 110*	*Street et al. (1994)*
Ly-768	Gönnersdorf	bulked bone	12,380 ± 230	Street *et al.* (1994)
OxA-3634	Grotte de Remouchamps, Belgium		10,320 ± 80	Charles (1994)
Lv-535	Grotte de Remouchamps	[conventional date]	10,380 ± 170	Charles (1994)
OxA-4190	Grotte de Remouchamps	cut humerus; capercaillie (*Tetrao urogallus*)	10,330 ± 110	Charles (1994)
OxA-4191	Grotte de Remouchamps	cut metacarpal; reindeer	10,800 ± 110	Charles (1994)
Lv-690	Grotte de Sy Verlaine, Belgium	bulked bone [conventional date]	13,780 ± 220	Charles (1994)
Lv-717	Grotte du Coléoptère, Belgium		12,400 ± 110	Street *et al.* (1994)
Lv-686	Grotte du Coléoptère		12,150 ± 150	Street *et al.* (1994)
KN-4023	Kartstein Abri, Germany	bone; bird (*Lagopus)*	10,090 ± 100	Street *et al.* (1994)
KN-4072	*Kartstein Abri*	*bone, reindeer*	*9,550 ± 90*	*Street et al. (1994)*
KN-4073	*Kartstein Abri*	*bone; reindeer*	*9,530 ± 90*	*Street et al. (1994)*
Hd-18123	Kettig, Germany	bone collagen	11,314 ± 50	Street & Baales (1997)
KN-3516	Miesenheim II, Germany	*Populus* sp.	11,230 ± 95	Street & Baales (1997)
KN-3517	Miesenheim II	*Populus* sp.	11,290 ± 95	Street & Baales (1997)
KN-3518	Miesenheim II	*Populus* sp.	11,080 ± 220	Street & Baales (1997)
KN-3519	Miesenheim II	*Populus* sp.	11,040 ± 220	Street & Baales (1997)
KN-3520	Miesenheim II	*Populus* sp.	11,070 ± 100	Street & Baales (1997)
KN-3531	Miesenheim II	*Populus* sp.	11,460 ± 100	Street & Baales (1997)

Radiocarbon Dates for Non-horse Material from Selected Continental European Sites

Lab No.	Site Name	Dated Material	^{14}C Date (BP)	Date Reference
KN-3532	Miesenheim II	*Populus* sp.	11,390 ± 90	Street & Baales (1997)
KN-3533	Miesenheim II	*Populus* sp.	11,460 ± 90	Street & Baales (1997)
KN-3534	Miesenheim II	*Populus* sp.	11,360 ± 110	Street & Baales (1997)
OxA-2068	Miesenheim II	?cervid (*Capreolus*)	10,820 ± 110	Street & Baales (1997)
OxA-2609	Miesenheim II	*Populus* sp.	10,960 ± 110	Street & Baales (1997)
OxA-2610	Miesenheim II	*Populus* sp.	10,960 ± 110	Street & Baales (1997)
OxA-2611	Miesenheim II	*Populus* sp.	11,030 ± 110	Street & Baales (1997)
OxA-2612	Miesenheim II	charcoal	10,880 ± 110	Street & Baales (1997)
OxA-2613	Miesenheim II	charcoal	11,040 ± 110	Street & Baales (1997)
OxA-2614	Miesenheim II	charcoal	11,060 ± 120	Street & Baales (1997)
OxA-2615	*Miesenheim II*	*mollusc*	*11,640 ± 120*	*Street & Baales (1997)*
OxA-2616	Miesenheim II	mollusc	11,370 ± 110	Street & Baales (1997)
Zürich	Miesenheim II	*Populus* sp.	10,840 ± 195	Street & Baales (1997)
OxA-1138	*Miesenheim II*	*?cervid (Capreolus)*	*10,600 ± 100*	*Street & Baales (1997)*
OxA-1132	*Neiderbieber I, Germany*	*bone; Cervus*	*10,700 ± 130*	*Street et al. (1994)*
OxA-2066	Neiderbieber II	elk	11,110 ± 110	Street & Baales (1997)
OxA-1133	*Neiderbieber II*	*?elk*	*9,750 ± 240*	*Street & Baales (1997)*
OxA-1136	*Neiderbieber IV*	*bone Cervus*	*10,480 ± 130*	*Street et al. (1994)*
OxA 2067	*Neiderbieber VII*	*bone; ?Cervus*	*10,390 ± 100*	*Street et al. (1994)*
Lv-1568	Trou de Chaleux, Belgium	bone splinters [conventional date]	12,370 ± 170	AM 18; Otte & Teheux (1986)
Lv-1569	Trou de Chaleux	bone splinters [conventional date]	12,990 ± 140	AM 18; Otte & Teheux (1986)
OxA-4192	Trou de Chaleux	cut phal I; musk ox	12,860 ± 140	AM 18
Lv-1136	Trou de Chaleux	bone splinters [conventional date]	12,710 ± 150	AM 18; Otte & Teheux (1986)
OxA-4193	Trou de Chaleux	cut humerus; pig	3,060 ± 85	AM 18

Radiocarbon Dates for Non-horse Material from Selected Continental European Sites

Lab No.	Site Name	Dated Material	^{14}C Date (BP)	Date Reference
Lv-1309D	Trou des Blaireaux, Belgium	[conventional date]	13,850 ± 335	Charles (1994)
Lv-1314	Trou des Blaireaux	[conventional date]	13,790 ± 150	Charles (1994)
Lv-1386	Trou des Blaireaux	[conventional date]	12,440 ± 180	Charles (1994)
Lv-1433	Trou des Blaireaux	[conventional date]	13,930 ± 120	Charles (1994)
Lv-1434D	Trou des Blaireaux	[conventional date]	13,730 ± 400	Charles (1994)
Lv-1558	Trou des Blaireaux	[conventional date]	16,130 ± 250	Charles (1994)
Lv-1385	Trou des Blaireaux	[conventional date]	16,270 ± 230	Charles (1994)
Lv-1137	Trou des Nutons, Belgium	bone splinters [conventional date]	7,720 ± 110	Charles (1994)
OxA-4194	Trou des Nutons	cut navicular cuboid; red deer	2,210 ± 80	Charles (1994)
OxA-4196	Trou du Frontal, Belgium	cut tibia; human	4,430 ± 80	Charles (1994)
GrN-10179	Trou du Frontal	bones; human [conventional date]	4,430 ± 30	Charles (1994)

Radiocarbon Dating References

The Journal: *RADIOCARBON* (RC)			
Abbreviation	**Year**	**Datelist Number**	**Date Reference**
RC1	1974	Birm VIII	Shotton *et al.* (1974)
RC2	1975	Birm IX	Shotton *et al.* (1975)
RC3	1960	BM II	Barker & Mackey (1960)
RC4	1968	BM V	Barker & Mackey (1968)
RC5	1969	BM VI	Barker *et al.* (1969)
RC6	1971	BM VII	Barker *et al.* (1971)
RC7	1976	BM VIII	Burleigh *et al.* (1976)
RC8	1982	BM XIV	Burleigh *et al.* (1982a)
RC9	1982	BM XV	Burleigh *et al.* (1982b)
RC10	1983	BM XVI	Burleigh *et al.* (1983)
RC11	1984	BM XVII	Burleigh *et al.* (1984)
RC12	1985	BM XVIII	Ambers *et al.* (1985)
RC13	1987	BM XIX	Ambers *et al.* (1987)
RC14	1987	BM XX	Ambers *et al.* (1987)
RC15	1989	BM XXI	Ambers *et al.* (1989)
RC16	1990	BM [recalc. dates]	Bowman *et al.* (1990)
RC17	1991	BM XXII	Ambers *et al.* (1991)
RC18	1994	BM XXIII	Ambers & Bowman (1994)
RC19	1974	Gif VIII	Delibrias *et al.* (1974)
RC20	1972	GrN X	Vogel & Waterbolk (1972)
RC21	1988	HAR VI	Walker & Otlet (1988)
RC22	1972	Lu V	Håkansson (1972)
RC23	1975	Lu VIII	Håkansson (1975)
RC24	1976	Lu IX	Håkansson (1976)
RC25	1977	Lu X	Hakansson (1977)
RC26	1979	Lu XII	Håkansson (1979)
RC27	1970	Lv IX	Gilot (1970)
RC28	1971	Ly II	Evin *et al.* (1971)
RC29	1973	Ly III	Evin *et al.* (1973a)
RC30	1973	Ly IV	Evin *et al.* (1973b)
RC31	1978	Ly VII	Evin *et al.* (1978)
RC32	1979	Ly VIII	Evin *et al.* (1979)
RC33	1985	Ly X	Evin *et al.* (1985)
RC34	1959	Q I	Godwin & Willis (1959)
RC35	1962	Q V	Godwin & Willis (1962)
RC36	1964	Q VI	Godwin & Willis (1964)
RC37	1975	Q XIII	Switsur & West (1975)
RC38	1976	R XIV	Allessio *et al.* (1976)
RC39	1978	R XVI	Allessio *et al.* (1978)
RC40	1968	TA III	Punning *et al.* (1968)
RC41	1971	VRI II	Felber (1971)
RC42	1994	Z XIII	Obelic *et al.* (1994)

Radiocarbon Dating References

The Journal: *ARCHAEOMETRY* (AM)			
Abbreviation	**Year**	**Datelist Number**	**Date Reference**
AM2	1985	datelist 2	Gillespie *et al.* (1985)
AM3	1986	datelist 3	Gowlett *et al.* (1986a)
AM4	1986	datelist 4	Gowlett *et al.* (1986b)
AM5	1987	datelist 5	Gowlett *et al.* (1987)
AM6	1987	datelist 6	Hedges *et al.* (1987)
AM7	1988	datelist 7	Hedges *et al.* (1988)
AM8	1988	datelist 8	Hedges *et al.* (1988)
AM9	1989	datelist 9	Hedges *et al.* (1989)
AM10	1990	datelist 10	Hedges *et al.* (1990)
AM11	1990	datelist 11	Hedges *et al.* (1990)
AM13	1991	datelist 13	Hedges *et al.* (1991)
AM14	1992	datelist 14	Hedges *et al.* (1992)
AM16	1993	datelist 16	Hedges *et al.* (1993)
AM18	1994	datelist 18	Hedges *et al.* (1994)
AM20	1995	datelist 20	Hedges *et al.* (1995)
AM21	1996	datelist 21	Hedges *et al.* (1996)
AM22	1996	datelist 22	Hedges *et al.* (1996)
AM23	1997	datelist 23	Hedges *et al.* (1997a)
AM24	1997	datelist 24	Hedges *et al.* (1997b)

Appendix Two

Morphological Nomenclature of the Horse and Description of the Measurements Used

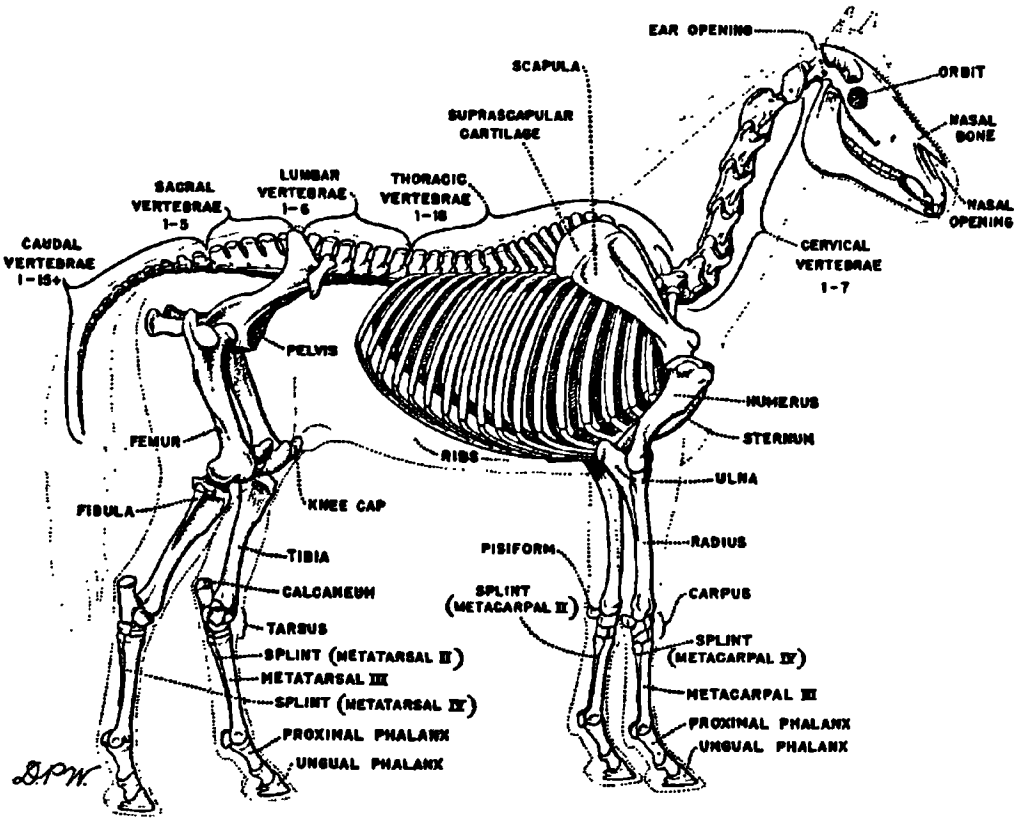
For the measurement figures in this appendix:

Abbreviations used in the present work are enclosed within brackets [...]

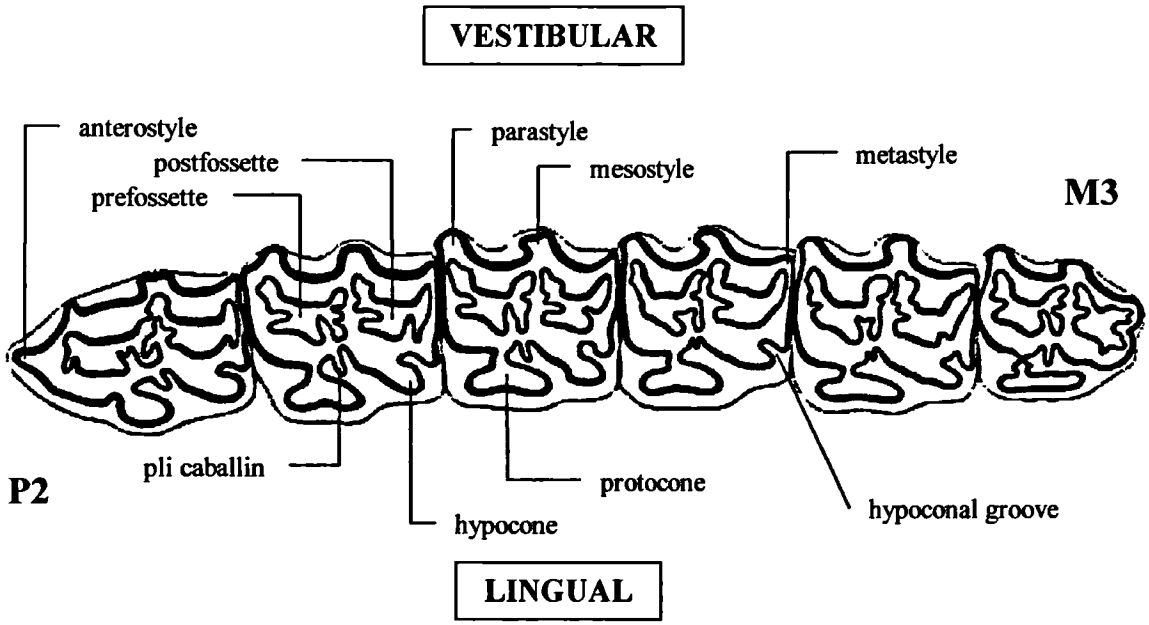
** denotes those measurements not illustrated in this appendix

Measurements in **BOLD** denote those used in chapter 5

Measurement illustrations from Eisenmann *et al.* (1988)



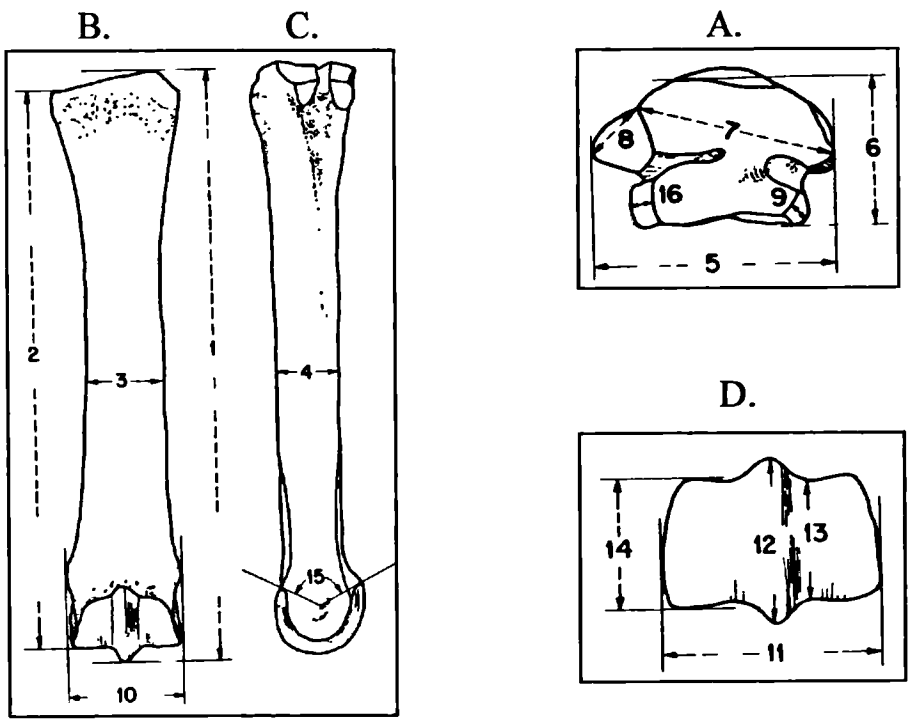
The skeletal elements of the horse including morphological nomenclature (from Stock and Howard, 1944). 'tarsus' = astragalus plus tarsal bones; 'proximal phalanx' = phal I; 'ungual phalanx' = phal III.



Upper cheek teeth morphology: the occlusal view of a left upper cheek tooth row (P2-M3) in the caballine horse, including morphological nomenclature (after Willoughby, 1974).

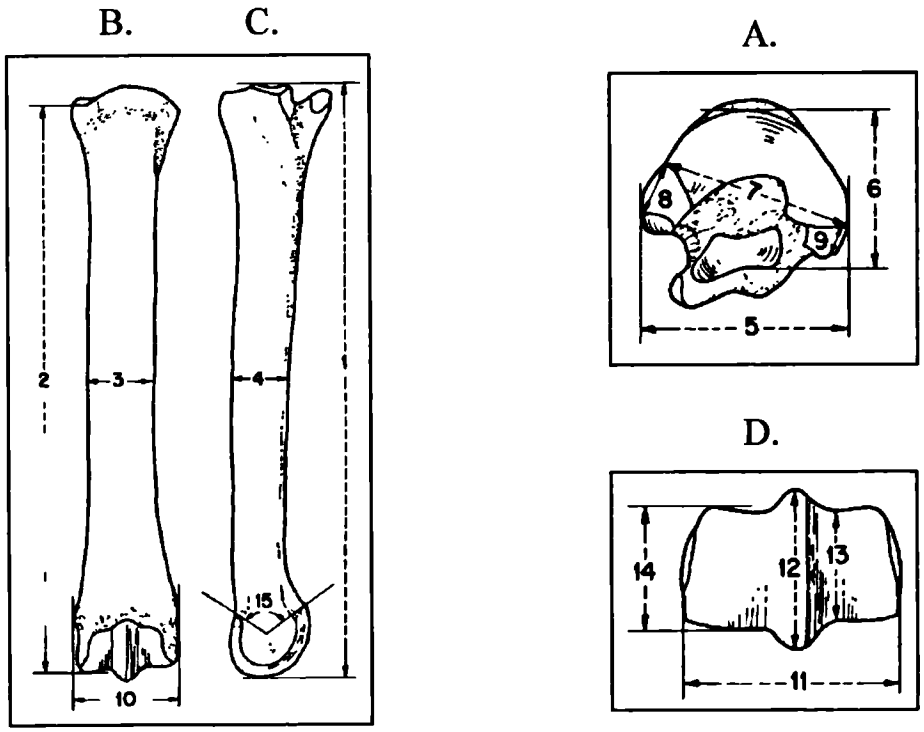
Description of Measurements for the Third Metacarpal [MCIII]	Eisenmann *et al.* (1988)	von den Driesch (1976)
1. Greatest length [GL]	**1**	**GL**
2. Medial length [Ml]	2	-
3. Smallest breadth of the diaphysis [SD]	3	SD
4. Depth of the diaphysis at level of 3 [SDd]	4	-
5. Greatest breadth of the proximal end [Bp]	**5**	**Bp**
6. Greatest depth of the proximal end (articular surface only) [Dp(a)]	6	-
7. Maximal diameter of articular facet for third carpal [Gdi3rd]	7	-
8. Diameter of anterior facet for fourth carpal [Di4th(ant)]	8	-
9. Diameter of articular facet for second carpal [Di2nd]	9	-
10. Distal maximal supra-articular breadth [Bd(s.a.)]	**10**	-
11. Distal maximal articular breadth [Bd(a)]	**11**	-
12. Distal maximal depth of keel (greatest depth of distal end) [Ddk]	**12**	**Dd**
13. Distal minimal depth of lateral condyle [Ddlc(min)]	13	-
14. Distal maximal depth of medial condyle [Ddmc(max)]	14	-
15. Angle measuring the dorso-volar development of the keel	15	-
16. Diameter of the posterior facet for the fourth carpal [Di4th(post)]	16	-
****Lateral length (outer side) [Ll]**	-	**Ll**
****Greatest breadth of the distal end [Bd(max)] (see 10 & 11 above)**	**10 or 11**	**Bd**
**Distal maximal depth of the lateral condyle [Ddlc(max)]	-	-
**Distal minimal depth of the medial condyle [Ddmc(min)]	-	-
**Greatest depth of proximal end [Dp(b)]	-	Dp
**Greatest length of the lateral part [GLl]	-	GLl

Left MCIII: A= Proximal view; B= Anterior view; C= Lateral view; D= Distal view



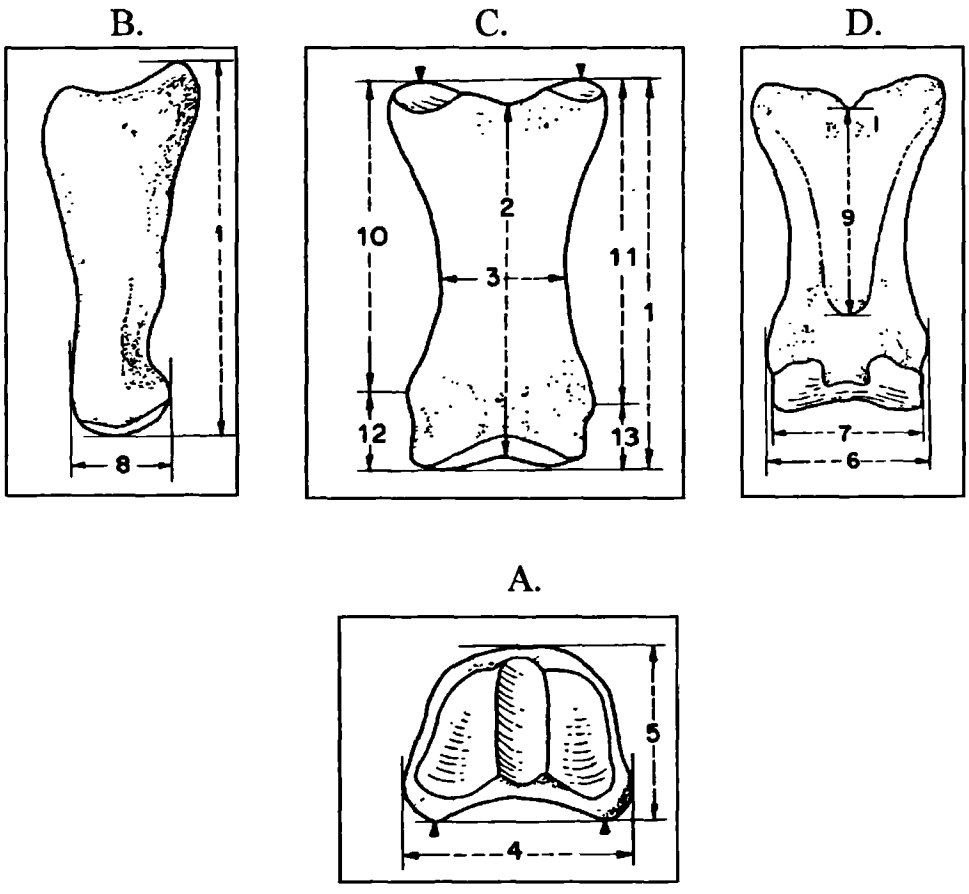
Description of Measurements for the Third Metatarsal [MTIII]	Eisenmann *et al.* (1988)	von den Driesch (1976)
1. Greatest length [GL]	**1**	**GL**
2. Medial length [Ml]	2	-
3. Smallest breadth of the diaphysis [SD]	3	SD
4. Depth of the diaphysis at level of 3 [SDd]	4	-
5. Greatest breadth of the proximal end [Bp]	**5**	**Bp**
6. Greatest depth of the proximal end (articular surface only) [Dp(a)]	6	-
7. Maximal diameter of articular facet for third tarsal [Gdi3rd]	7	-
8. Diameter of articular facet for fourth tarsal [Di4th]	8	-
9. Diameter of articular facet for second tarsal [Di2nd]	9	-
10. Distal maximal supra-articular breadth [Bd(s.a.)]	**10**	-
11. Distal maximal articular breadth [Bd(a)]	**11**	-
12. Distal maximal depth of keel (greatest depth of distal end) [Ddk]	**12**	**Dd**
13. Distal minimal depth of lateral condyle [Ddlc(min)]	13	-
14. Distal maximal depth of medial condyle [Ddmc(max)]	14	-
15. Angle measuring the dorso-volar development of the keel	15	-
Lateral length (outer side) [Ll]	-	**Ll**
****Greatest breadth of the distal end [Bd(max)] (see 10 & 11 above)**	**10 or 11**	**Bd**
**Distal maximal depth of the lateral condyle [Ddlc(max)]	-	-
**Distal minimal depth of the medial condyle [Ddmc(min)]	-	-
**Greatest depth of proximal end [Dp(b)]	-	Dp
**Greatest length of the lateral part [GLl]	-	GLl

Left MTIII: A= Proximal view; B= Anterior view; C= Lateral view; D= Distal view



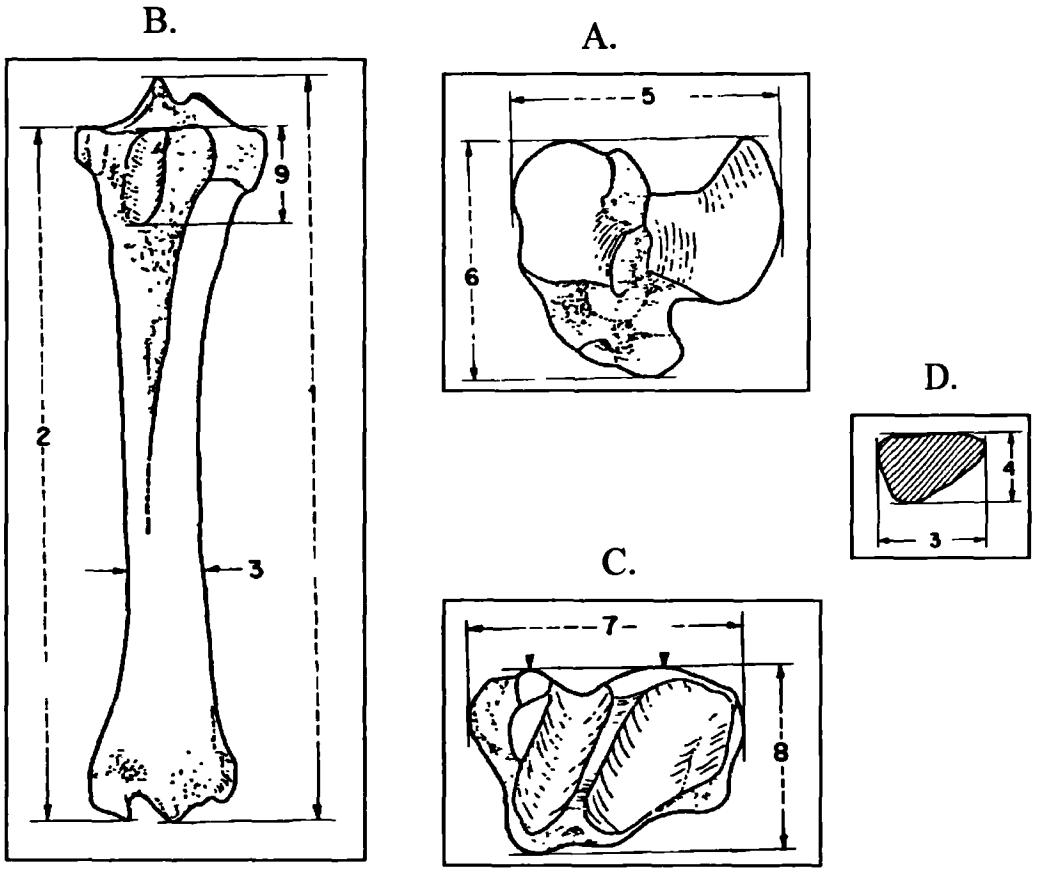
Description of Measurements for the First Phalanx [Phal I]	Eisenmann *et al.* (1988)	von den Driesch (1976)
1. Greatest length [GL]	**1**	**GL**
2. Anterior length [L(ant)]	2	-
3. Smallest breadth of the diaphysis [SD]	**3**	**SD**
4. Greatest breadth of the proximal end [Bp]	**4**	**Bp**
5. Depth of the proximal end [Dp]	**5**	**Dp**
6. Greatest breadth of the distal end [Bd]	6	Bd
7. Greatest breadth of the facies articularis distalis [BFd]	7	BFd
8. Depth of the distal end [Dd]	8	-
9. Smallest length of the trigonum phalangis [SL(tphal)]	9	-
10. Medial supratuberosital length [Lm(supra)]	10	-
11. Lateral supratuberosital length [Ll(supra)]	11	-
12. Medial infratuberosital length [Lm(infra)]	12	-
13. Lateral infratuberosital length [Ll(infra)]	13	-

Left Phal I: A= Proximal view; B= Lateral view; C= Anterior/Dorsal view; D= Posterior/Ventral view



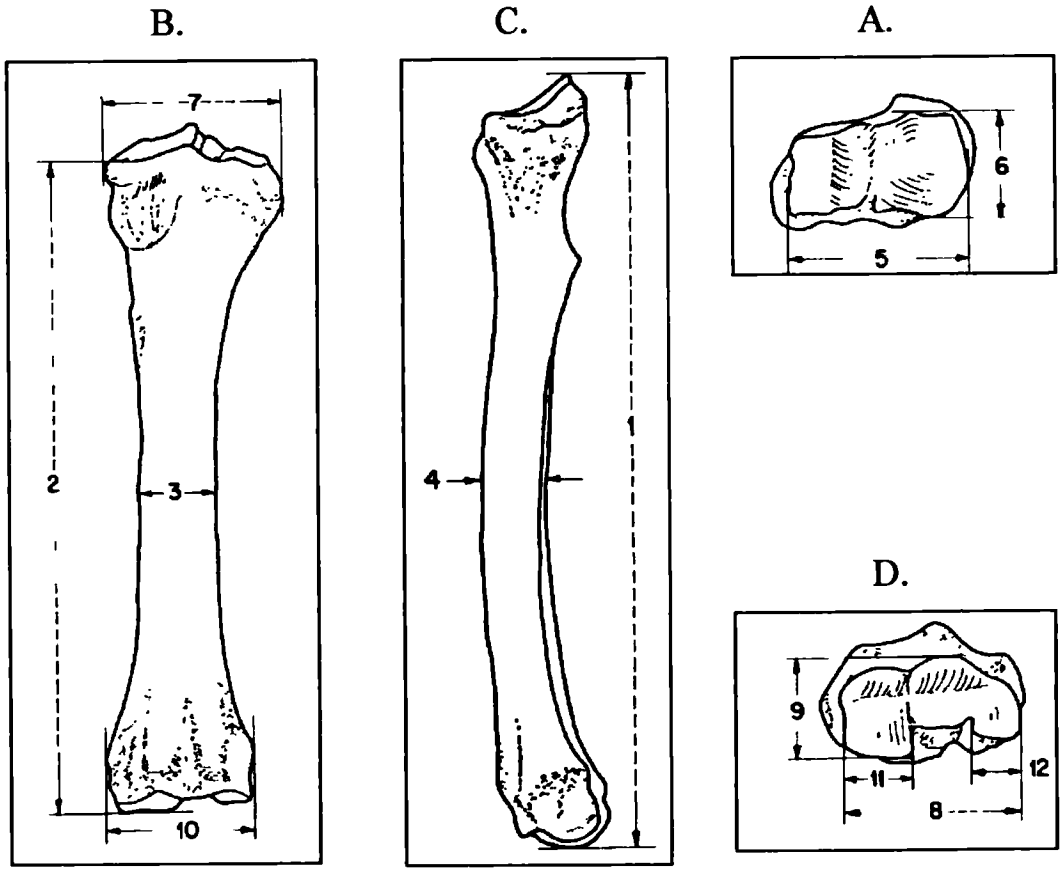
Description of Measurements for the Tibia	Eisenmann *et al.* (1988)	von den Driesch (1976)
1. Greatest length [GL]	1	GL
2. Medial length [Ml]	2	-
3. Smallest breadth of the diaphysis [SD]	3	SD
4. Minimal depth of the diaphysis (at level of 3) [SDd]	4	-
5. Greatest breadth of the proximal end [Bp]	5	Bp
6. Proximal maximal depth [Dp]	6	-
7. Greatest breadth of the distal end [Bd]	7	**Bd**
8. Greatest depth of the distal end [Dd]	8	**Dd**
9. Length of the fossa digitalis [Lfd]	9	-
**Lateral length of the outer side [Ll]	-	Ll

Left Tibia: A= Proximal view; B= Anterior view; C= Distal view; D= Cross-section at level of arrow 3



Description of Measurements for the Radius	Eisenmann *et al.* (1988)	von den Driesch (1976)
1. Greatest length [GL]	1	GL
2. Medial length [Ml]	2	-
3. Smallest breadth of the diaphysis [SD]	3	SD
4. Depth of the diaphysis at level of 3 [SDd]	4	-
5. Greatest breadth of the facies articularis proximalis [BFp]	**5**	**BFp**
6. Proximal articular depth [DFp]	6	-
7. Greatest breadth of the proximal end [Bp]	7	Bp
8. Greatest breadth of the facies articularis distalis [BFd]	8	BFd
9. Distal articular depth [DFd]	9	-
10. Greatest breadth of distal end [Bd]	**10**	**Bd**
11. Breadth of the radial condyle [B(rcond)]	11	-
12. Breadth of the ulnar condyle [B(ulcond)]	12	-
**Lateral length [Ll]	-	Ll

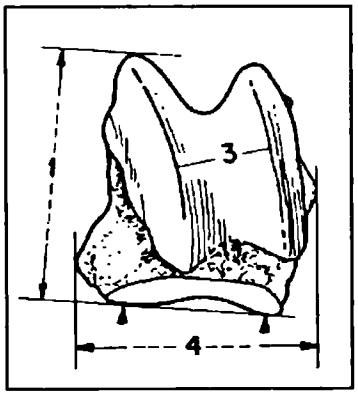
Left Radius: A= Proximal view; B= Anterior view; C= Lateral view; D= Distal view



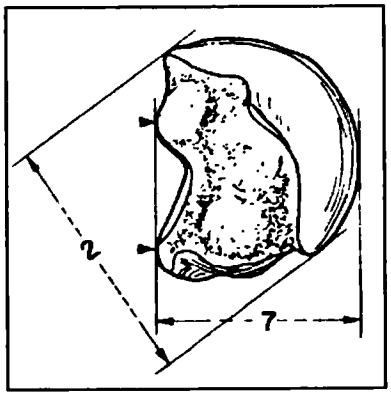
Description of Measurements for the Astragalus	Eisenmann *et al.* (1988)	von den Driesch (1976)
1. Greatest height [GH]	-	GH
2. Length of the medial part of the trochlea tali [LmT]	2	LmT
3. Breadth of the trochlea (at the apex of each condyle) [Btroch]	3	-
4. Greatest breadth [GB]	**4**	**GB**
5. Breadth of the facies articularis distalis [BFd]	**5**	**BFd**
6. Depth of the facies articularis distalis [DFd]	6	DFd
7. Greatest medial depth [GDm]	7	-
**Greatest length from the medial condyle to the most distal point on the lateral part of the distal articular surface [GHII]	-	-

Left Astragalus: A= Anterior view; B= Medial view; C= Distal view

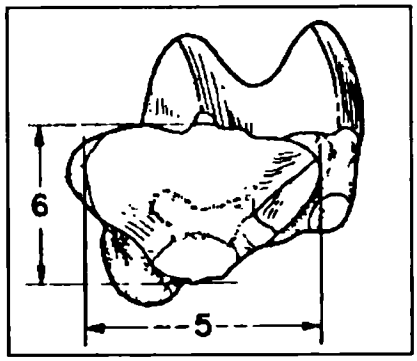
A.



B.



C.

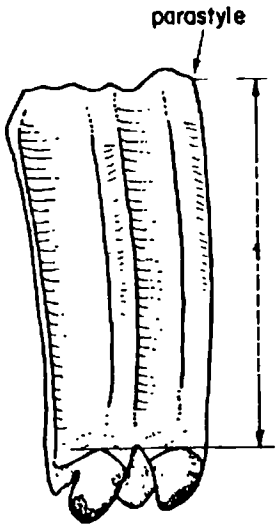


Description of Measurements for the Upper Cheek Teeth [P2 & M3]	Eisenmann *et al.* (1988)	Musil (1969)
1. Tooth height [Ht]	1	-
2. Occlusal length [L]	2	1
3. Occlusal length of the protocone [LP]	3	5
4. Occlusal breadth [B]	4	-

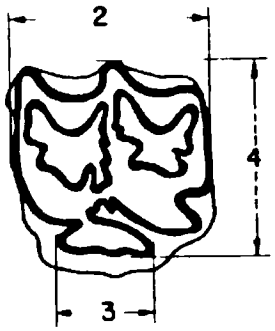
Upper left cheek tooth: A: Vestibular view; B: Occlusal view.

Please note: tooth height measured at the anterostyle for P2s and at the parastyle for M3s.

A.



B.



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